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VOLUME 9 NUMBER 1

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JANUARY, 1929

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO, ILLINOIS. ANNUAL SUBSCRIPTION, $6.00

Entered as Second-Class Matter, January 14, 1925, at the Postoffice at Chicago, Illinois, under the Act of March 3, 1879. Acceptance for mailing at special rate provided for in Section 1103, Act of October 3, 1917, authorized January 22, 1925.

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ARCHIVES OF OTOLARYNGOLOGY

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THE CLINICAL SIGNIFICANCE OF SPONTANEOUS NYSTAGMUS *

HANS BRUNNER, M.D.

VIENNA, AUSTRIA

Because its anatomic basis is best known, spontaneous nystagmus is the most important symptom produced by the labyrinth. To be sure, a great many questions concerning it have not yet been definitely settled; the most essential ones, however, can be regarded as being solved at present. But the clinical evaluation of spontaneous nystagmus is made somewhat more difficult because this nystagmus can be produced by various organs. The labyrinth, the eyes and the brain will be considered here. From the otologist's point of view, one can, therefore divide spontaneous nystagmus into a labyrinthine and a nonlabyrinthine type of nystagmus. This division is justified from a purely practical standpoint for the reason especially that labyrinthine nystagmus permits certain conclusions with regard to the localization and type of disease in question. The pathogenesis of nonlabyrinthine nystagmus is obscure in many respects even today, so that diagnostic conclusions based on this type of nystagmus are as yet hardly possible.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis between labyrinthine and nonlabyrinthine nystagmus cannot always be arrived at; nevertheless, in the great majority of cases this differential diagnosis can be successfully made, and for this purpose I utilize the following points:

1. *Dizziness.*—Labyrinthine nystagmus is always accompanied by labyrinthine dizziness (turning dizziness, tactile dizziness)—nonlabyrinthine nystagmus may be accompanied by dizziness; however, it is not of labyrinthine character.

2. *Association of Eye Movements.*—Spontaneous labyrinthine nystagmus always exhibits associated eye movements. This applies as well in those cases in which paralysis of the eye muscle and spontaneous labyrinthine nystagmus appear simultaneously. When, therefore, spontaneous nystagmus shows dissociated eye movements, one may be sure it is of nonlabyrinthine origin.

3. *Form of Nystagmus.*—Spontaneous labyrinthine nystagmus, in its typical form, is combined horizontal and rotatory, or only rotatory. Diagonal spontaneous nystagmus is practically always, and vertical spontaneous nystagmus is

* Submitted for publication, April 5, 1928.

* From the Ear Department of the Allgemeine Poliklinik in Vienna, Chief, Prof. Dr. G. Alexander.

* Translated from the original by Frances Richman, M.D., Brooklyn.

often, of nonlabyrinthine origin. However, if vertical nystagmus is accompanied by labyrinthine dizziness, it is of labyrinthine origin.

4. *Inversion of Experimental Optical Nystagmus* (Bárány, Brunner).—I investigate optical nystagmus by means of the revolving umbrella of Brunner. This apparatus consists of a paper cylinder having a height of 30 cm. and a diameter of 70 cm. On the inner surface of this cylinder are six vertical black stripes which occur at intervals of 30 cm. The cylinder is suspended and the patient is seated within its circle. The lower border of the umbrella should lie approximately on a level with the superior orbital border. The patient is told to look at the black stripes while the observer faces the patient and revolves the umbrella slowly with his right hand.

If one examines a normal person with this apparatus, coarse horizontal nystagmus to the left is observed when the umbrella is turned to the right, and vice versa. If one then examines a patient who has spontaneous labyrinthine nystagmus, the results are the same as those obtained in a normal person. In other words, the spontaneous labyrinthine nystagmus is suppressed by the experimental optical nystagmus. If now one subjects a patient with spontaneous nonlabyrinthine nystagmus to this test, abnormalities are seen in the experimental optical nystagmus, these being grouped under the term "inversion of experimental optical nystagmus." They may manifest themselves as nystagmus in the same direction in which the umbrella is being turned (nystagmus to the right on turning the umbrella to the right, and vice versa), or as a complete absence of nystagmus, or as nystagmus that appears normal but is of slow movement. In order to render this "inversion" clearer, I shall describe several patients who came under observation in the ear department of the Allgemeine Poliklinik of Vienna and were examined with the revolving umbrella.

REPORT OF CASES

CASE 1.—*History.*—E. J., a boy, aged 11, had convulsions during childhood, and strabismus one year later. Since 1918 there had been trembling of both eyes; he is the only member of the family in whom this condition has been observed. Syphilis was not present.

The ear drums were retracted and the tonsils hypertrophied. The functional test revealed a normal cochlea. When the patient looked straight ahead, nystagmus to the left was present; when he looked to the left, there was an irregular tremor of the eyes; when he looked toward the right, there were several nystagmic movements to the right.

Turning Chair Tests.—After ten turns to the right with the head bent forward 90 degrees, there was intensive nystagmus to the left when the patient looked straight ahead. When he looked to the right, there was nystagmus to the left; when he looked to the left, the nystagmus to the left was reduced. Dizziness was not present. Typical pastpointing was observed. Ten turns to the left (with the head 90 degrees forward) produced intensive nystagmus to the right when the patient looked straight ahead. When he looked to either side the nystagmus grew less. Dizziness was not observed. Typical pastpointing was obtained.

Ten turns to the right (with the head on the left shoulder) produced intensive horizontal nystagmus to the left. He fell forward. Ten turns to the left (with

the head on the left shoulder) produced diagonal nystagmus to the right and down when he looked to the left. He fell backward.

After ten turns to the right (with the head on the right shoulder), there was intensive horizontal nystagmus to the left. Ten turns to the left (with the head on the right shoulder) produced intensive horizontal nystagmus to the right.

Caloric Test.—The spontaneous nystagmus was not affected by this test. Neither did the galvanic test influence the spontaneous nystagmus or produce dizziness.

Umbrella Test.—When the umbrella was turned to the left, with the eyes in the midposition, a nystagmus to the left was observed. When the umbrella was turned to the right, with the eyes in the midposition, nystagmus was not produced; when the eyes were turned to the right, there were a few nystagmic jerks to the right.

This case was a typical example of spontaneous, nonlabyrinthine nystagmus. It is characteristic of these cases that the spontaneous nystagmus is scarcely influenced by the usual methods of examining the labyrinth. Thus, with the caloric and galvanic tests no reaction was obtained and with the turning test the effect on the spontaneous nystagmus was atypical. It is in such cases that one often has difficulty in determining whether the labyrinth is present or not, since, with the ordinary irritation methods, a typical nystagmus cannot be produced. Therefore, I recommend that the nystagmus be ignored in these cases, and that the "walking test" be applied. This examination is carried out as follows: The patient is turned, for example, ten times to the right. After the turning he is asked to walk straight ahead with the eyes closed. If the labyrinths are irritable, he will not be able to walk straight ahead, but will walk to the right. In case 1, the typical falling reaction and the typical pointing reaction indicate that the labyrinth was irritable. In this patient, "inversion" also was present in typical form—when I turned the umbrella to the left, there was nystagmus to the left instead of to the right, and when I turned it to the right, instead of nystagmus to the left there was no nystagmus. These abnormalities in the experimental optical nystagmus were sure signs that the spontaneous nystagmus of the patient was not of labyrinthine origin.

CASE 2.—*History.*—W. B., a boy, aged 13, had convulsions in early childhood. His mother had poor vision. No one else in the family had a tremor of the eyes. The mother had noticed the trembling of the child's eyes only within a few weeks before examination.

The ear drums were dull. Functional testing of the cochlea yielded a normal result with the exception of a negative Rinne reaction. When the patient looked straight ahead nystagmus was not present. When he looked to the left, there was horizontal nystagmus to the left; when he looked to the right, there was horizontal nystagmus to the right. When the right eye was covered, there appeared in the left eye a coarse nystagmus to the left. When the left eye was covered, the right eye was quiet at first; later, however, it showed a few nystagmic movements to the right.

Turning and Caloric Tests.—The reactions in these tests were typical. When a caloric nystagmus was produced to the right and the right eye was closed, there

appeared in the left eye a latent nystagmus to the left, but it was not so marked as it was without the caloric irritation. When the right eye was opened again, the typical caloric nystagmus to the right reappeared.

Umbrella Test.—Turning the umbrella to the right produced either several nystagmic movements to the left or no nystagmus. When the umbrella was turned to the left, there were at first a few nystagmic jerks to the left; then the eyes remained quiet but the patient showed a head nystagmus.

This case was a typical example of the so-called "latent nystagmus." This type of nystagmus is characterized by the fact that when one eye is closed, there appears in the open eye a nystagmus in the direction of the open eye; i.e., when the right eye is closed, there appears in the left eye a nystagmus to the left, and vice versa. Latent nystagmus has been known for a long time, but it was always thought to be a rare phenomenon. Kestenbaum showed that this form of nystagmus is not nearly so rare as it was formerly considered to be, and that it may appear either unilaterally or bilaterally. In my case the latent nystagmus was unilateral, for it was produced clearly only by closure of the right eye. My case showed also that there was a much more powerful basis for the mechanism of latent nystagmus than there was for caloric nystagmus for, if a caloric nystagmus was produced to the right and the right eye was covered, then, in spite of the caloric nystagmus in the opposite direction, there appeared in the open left eye a latent nystagmus to the left. This phenomenon was first described by Brunner.

This patient, also, showed an "inversion." When the umbrella was turned to the right, he showed a nystagmus to the left, as under normal conditions, but this nystagmus to the left was markedly weakened and at times absent. When the umbrella was turned to the left, the patient did not show any nystagmus of the eyes, but did show nystagmus of the head. Nystagmus of the head is frequently found combined with nystagmus of the eyes in spasmus nutans, a disease which occurs chiefly in the spring in infants reared in dark rooms. However, this nystagmus of the head can occasionally be produced in infants by the caloric test. Also in adults it is possible, now and then, to produce a nystagmus of the head by means of the caloric test; more rarely, the turning test will elicit it. Once in a great while one is fortunate enough to demonstrate nystagmus of the head in adults by means of the umbrella test. The question why certain patients should show this nystagmus of the head and the majority should not cannot be definitely answered at present.

CASE 3.—*History.*—H. K., a woman, aged 49, had not had any previous illness. She did not have any children.

The drum membranes were normal. Functional testing of the cochlea gave normal results with the exception of a negative Rinne reaction on the left. When she looked straight ahead, there was no nystagmus. When she looked to the left, there was slight horizontal nystagmus to the left. When she looked to the right,

there was horizontal nystagmus to the right about twice as rapid in the left eye as in the right. Closure of the left eye elicited a nystagmus to the right in the right eye; closure of the right eye elicited a nystagmus to the left in the open left eye.

Caloric Test.—This test was performed in the optimum position of Bruenings. (All subsequent observations were made with the eyes in the midposition.) Cold water in the right ear produced at first a nystagmus to the right (!) which, however, soon changed to a nystagmus to the left. Falling and pointing reactions were typical. If, while the intensity of the caloric nystagmus to the left was still marked, the left eye was closed, the nystagmus to the left in the open eye diminished. Soon this nystagmus was completely suppressed, and a latent nystagmus to the right became manifest in the open right eye. If the left eye was uncovered, the previously suppressed caloric nystagmus to the left was again seen in the right eye. During these observations, dizziness was not present. Corresponding conditions were found in the caloric test on the left side.

Umbrella Test.—Turning the umbrella to the left produced a nystagmus to the right; turning the umbrella to the right did not produce nystagmus.

Again in this case there was a latent nystagmus and a one-sided "inversion." The connections between latent and caloric nystagmus could be satisfactorily studied in this patient. It is seen that in this respect the conditions are the same in grown-ups and in young boys.

Case 4.—*History.*—R. J., a woman, aged 30, with one healthy child, had not had any previous illness nor any labyrinthine dizziness.

The ear drums were normal, as was the functional reaction of the cochlea. When she looked to the right, a slight horizontal nystagmus was present. Closure of the right eye produced a nystagmus to the left in the open left eye, and vice versa.

Turning Test.—Ten turns to the right produced dizziness of short duration and temporary nystagmus to the left which was suppressed by closure of the left eye. Corresponding conditions prevailed after ten turns to the left.

Umbrella Test.—The results in this test were normal. If the left eye was covered and the umbrella turned to the left, the latent nystagmus to the right in the open right eye increased. When the umbrella was turned to the right, the latent nystagmus to the right in the open right eye was suppressed and no nystagmus was present. When the right eye was covered and the umbrella was turned, an experimental optical nystagmus was produced in typical form on both sides.

This case showed that latent nystagmus can sometimes easily be suppressed by examination with the revolving umbrella.

Case 5.—*History.*—S. B., a girl, aged 18, had learned to talk at the age of 6 years, and even at the time of examination her speech was poorly developed. She was in a school for feebleminded children. Her hearing was good. She did not have convulsions, enuresis or any signs of hereditary syphilis. Formerly she had talked to herself. For the year previous to examination she had had periods of great excitation, singing, screaming, jumping and talking to herself. Her sleep was disturbed. The words she spoke were connected, but the sentences did not have any meaning. Trembling of the eyes and strabismus had been present since birth.

The external canals were narrow. The ear drums, as far as they could be seen, were normal as was the hearing. Adenoids were present. Spontaneous nystagmus was not present, but there was typical latent nystagmus.

Turning Test.—After ten turns to the right there was a typical falling reaction, but no nystagmus. If the left eye was closed after the ten turns to the right, the latent nystagmus to the right that was present in the open right eye before the turning was not observed. Similar conditions prevailed after ten turns to the left.

After ten turns to the right with the head on the right shoulder nystagmus was not apparent, but there was a marked dizziness and a typical falling reaction. Corresponding conditions prevailed after ten turns to the left.

Umbrella Test.—The patient could not be prevailed on to fix the black stripes; therefore, it was impossible to demonstrate an optical nystagmus.

In this case the turning test did not produce nystagmus, in spite of the fact that the patient had no spontaneous nystagmus (aside from her latent nystagmus), and in spite of the fact that her labyrinths were irritable. That the labyrinths were irritable was proved by the typical falling reaction after the turning test, and by the fact that it was possible to suppress the latent nystagmus with the turning test. This case clearly showed that in imbeciles with abnormalities in the movements of the eye it is often difficult to answer with certainty the apparently simple question whether or not the patient has an active labyrinth. The case showed also that now and then it may be impossible in such patients to utilize the umbrella test, namely, when they cannot be induced to fix the black stripes.

CASE 6.—*History.*—S. R., a boy, aged 15, had convulsions during childhood. Following the convulsions, a convergent strabismus developed and was present when the child entered school. He began to talk when he was 2 years old. He did not speak distinctly even at the time of his examination, but he understood everything. At school he did good work, but could not write because his vision was poor and because sensation in his hand was not good. For the same reason, he could not do much work either. His mother could not say definitely when the tremor of eyes began.

The drum membranes and hearing were normal. When he looked to the right, there was horizontal-rotatory nystagmus to the right; when he looked to the left, there was transient nystagmus to the left; when he looked upward, there were several nystagmic movements to the left; when he looked straight ahead, there was rotatory nystagmus to the right. Typical latent nystagmus was observed. There was no Romberg sign and the fistula symptom of Alexander-Hennebert was negative.

Turning Test.—After ten turns to the right (head 90 degrees forward), there was a transient nystagmus to the left. If the left eye was immediately covered after the turning, the postrotation nystagmus present in the right eye became suppressed, the eye deviated slightly to the left and the latent nystagmus to the right appeared. There was a typical falling reaction. Corresponding conditions prevailed after ten turns to the left with the head 90 degrees forward.

Caloric Reaction.—Cold water in the left ear produced a typical falling reaction to the left and a typical nystagmus to the right which could be suppressed on closure of the right eye. Corresponding results were obtained on testing the right ear.

Galvanic Test (bipolar method).—Galvanic nystagmus was not elicited with 5 milliamperes, nor was the latent nystagmus influenced. But a typical labyrinthine dizziness was produced.

Umbrella Test.—When the umbrella was turned to the left, a nystagmus to the left appeared; when it was turned to the right, there was no nystagmus. If one eye was covered so that the latent nystagmus appeared, and then the patient was made to fix the black stripes with the open eye, the latent nystagmus was not influenced by the turning of the umbrella.

This case, also, showed the relationship between latent and labyrinthine nystagmus. The only surprising point was the fact that the latent nystagmus was not influenced by the turning of the umbrella. However, I could not draw any far-reaching conclusions in this case, for the patient was an imbecile, and it has already been observed that in imbeciles examination with the revolving umbrella does not yield reliable results.

CASE 7.—*History.*—O. P., a boy, aged 10 years, had convulsions and trembling of the eyes at the age of 4 months, followed by strabismus convergens. Later the strabismus decreased. There were frequent pains in the left half of the forehead, and vomiting occurred often. His mother and one sister had died in an insane asylum. His mother had had twenty children, eleven of whom had died of convulsions. No one else in the family had trembling of the eyes.

Neurologic observations were negative. The drum membranes were retracted. The hearing was normal. When he looked straight ahead there was a rapid rotatory nystagmus to the right (160 a minute). When he looked to the right, there was a horizontal nystagmus to the right, particularly in the right eye. When the patient looked to the left, there were several nystagmic motions to the left, particularly in the left eye. When he looked upward, there was rotatory nystagmus to the right; when he looked downward, the rotatory nystagmus was suppressed. A typical latent nystagmus was present.

Turning Test.—After ten turns to the right (head 90 degrees forward), there were from four to five horizontal eye motions to the left. A typical pointing reaction was observed. After ten turns to the left (head 90 degrees forward), the patient at first showed a vertical nystagmus downward, especially in the right eye, and then several horizontal eye motions to the right. There was a typical pointing reaction.

After ten turns to the right (head on the right shoulder), an intensive diagonal nystagmus to the left and down appeared; later, there was a vertical nystagmus downward, and still later a rotatory nystagmus to the right. After ten turns to the left (head on the right shoulder), a mild diagonal nystagmus to the right and upward was observed. After the turning there was labyrinthine dizziness and nausea. After ten turns to the right (head on the left shoulder), there were several diagonal motions to the left and up. Dizziness was not present. After ten turns to the left (head on the left shoulder), there was diagonal nystagmus to the right and down; later there was vertical nystagmus downward, and still later rotatory nystagmus to the right.

Umbrella Test.—Normal results were obtained in this test. On two other occasions, it was impossible to produce a nystagmus to the right with the revolving umbrella (inversion).

Caloric Test.—Cold water in the left ear produced a horizontal nystagmus to the right, combined with the spontaneous rotatory nystagmus. Dizziness and nausea were present. Cold water in the right ear yielded a normal result.

In addition, this case showed exceedingly well that the labyrinthine nystagmus is variable if a spontaneous nonlabyrinthine nystagmus is present. It was of interest, furthermore, to note that at one examination "inversion" could not be demonstrated, even though the patient had a marked spontaneous nonlabyrinthine nystagmus (similar to that of patient 4). This does not happen often, but it shows that clinically only the observation of an "inversion" is of importance, while the appearance of normal results in the examination with the revolving umbrella does not permit one to draw definite conclusions.

We see, therefore, that the umbrella test and the three other points just enumerated help most in establishing the differential diagnosis between a labyrinthine and nonlabyrinthine nystagmus. After one has diagnosed a spontaneous nystagmus as of labryrinthine origin, there is another question to answer; namely, whether the nystagmus is of peripheral labyrinthine or of central labyrinthine origin. By the term peripheral labyrinthine nystagmus is meant one that is caused by an organic disease of the peripheral sense organs (maculae, cristae) or their nerves. A central labyrinthine nystagmus is one that is the result of an organic or vasomotor disease of the central paths of the labyrinthine nerve.

In order to answer this question, I make use of three diagnostic aids:

1. In peripheral labyrinthine nystagmus one finds, as a rule, that the intensity of the nystagmus conforms directly to the intensity of the dizziness. In central labyrinthine nystagmus this conformity may be wanting. That this rule actually holds true will be shown in the following two interesting cases:

Case 8.—*History.*—E. B., a man, aged 52, who had six healthy children, had influenza twenty years before examination. Following the influenza, there was weakness in the left arm and left leg, and interference with swallowing and speaking. He had difficulty in swallowing liquids. At one time the disturbances disappeared, but in 1916 his symptoms returned. He became dizzy so that he could not walk straight ahead but always walked to the left. Even at the time he was examined he was subject to attacks of dizziness. He had the sensation of being turned to the left. When he had this vertigo it was necessary for him to hold on to something in order to avoid falling. He had fallen a few times in the street and at home. He did not have syphilis and did not overindulge in smoking or in alcohol.

The left membrana tympani was normal. On the right side there was otitis externa; the drum membrane was covered with crusts. Hearing on both sides was slightly diminished. The response to the Weber test was to the right. The Rinne reaction was negative on the right. When he looked to the right, there was rotatory nystagmus to the right; when he looked to the left, there were several nystagmic motions to the left. A Romberg sign could not be elicited.

Caloric Test and Umbrella Test.—These tests yielded absolutely normal results.

Nerve Observation.—The left trigeminus was hypesthetic; the left half of the tongue was atrophic; the left half of the soft palate was relaxed. Abdominal reflexes were absent. The patellar and achilles reflexes were exaggerated on both sides. There was paresis of the left leg. Hypalgesia was present in the left half of the neck, extending to the outer surface of the arm. The Wassermann reaction in the blood was negative.

The interference with swallowing and with talking in the beginning of the illness pointed definitely to a disease of the medulla oblongata. The one-sided atrophy of the tongue, the unilateral paralysis of the soft palate and the chronic character of the illness, made one think of a syringomyelia. As a matter of fact, a number of neurologists in Germany and in Vienna who examined the patient made this diagnosis.

The case is seen to be of interest, then, only so far as the patient shows a mild degree of nystagmus (perhaps because the disease may have been in the midregion of the medulla oblongata) combined with severe attacks of labyrinthine dizziness. One perceives at once in this case that the intensity of the dizziness and the intensity of the nystagmus did not correspond.

CASE 9.—*History.*—J. F., a woman, aged 40, who had five healthy children, in the summer of 1918 suddenly became dizzy. She lay in bed and suddenly felt as though she were being turned to the right, and she fell toward the right. Previously she had complained of some interference with her sight, but after the attack her vision became worse. Examination at the eye clinic revealed a normal eyeground. At the time of examination she still had occasional vertigo and pains in the occiput.

The drum membranes were normal, as was the hearing. There was rotatory nystagmus of the third degree to the right. In the Romberg position she fell to the right. There was inconstant pastpointing of the right arm to the right.

Caloric Test.—This test produced only a mild nystagmus (considering her intensive spontaneous nystagmus), but her labyrinths were undoubtedly irritable.

Umbrella Test.—A normal result was obtained.

First Neurologic Observation.—The facial nerve on the left side was less innervated than that on the right. The corneal reflex on the right side was weaker than that on the left. Slight adiadokokinesis was present in the right arm. The lower right abdominal reflex was markedly reduced. The right patellar reflex was more marked than the left. A positive Babinski reflex was obtained on the right side.

Second Neurologic Observation.—Painfulness was noted in the right mastoid process. Hypalgesia was noted in the first branch of the right trigeminus. The corneal reflex on the right was reduced. The facial nerve was intact. There was ataxia of the right arm and paresis of the right arm with a diminished tendon reflex. The abdominal and patellar reflexes were symmetrical. The gait was disturbed.

This case is of interest because it was uncertain for a long time whether we were dealing with a cerebellar tumor or with a multiple sclerosis. To be sure, the prolonged absence of papilledema (numerous

examinations were made) and the variations in the neurologic observations soon made probable the diagnosis of multiple sclerosis. At this time, the diagnosis can be made with certainty, for the patient has been under observation for eight years. The disease has not progressed (also, there has not been any papilledema); on the contrary, aside from her headaches and occasional spells of dizziness, she feels well.

But the case is of interest also from an otologic point of view, for it indicates that in spite of the existence of an intensive labyrinthine nystagmus, the experimental optical nystagmus occurs normally—this, as I have shown, being the rule. It further shows satisfactorily the disharmony between the intensity of the nystagmus and the intensity of the dizziness: the patient had had a most intensive nystagmus to the right for the past eight years, yet she complained only occasionally of mild attacks of dizziness. Such nystagmus would naturally be accompanied by severe dizziness if it were caused by the labyrinth. Finally, the case is of interest also because during the entire course of the disease the patient fell to the right, i.e., in the direction of the quick component of her nystagmus. This observation leads us to the second diagnostic aid in the differential diagnosis between peripheral and central labyrinthine nystagmus:

2. In peripheral labyrinthine nystagmus the patient falls, as a rule, in the direction of the slow component of the nystagmus, and this falling reaction is often dependent on the position of the head. In central labyrinthine nystagmus the patient may fall in the direction of the quick component of the nystagmus, and this falling reaction is, as a rule, independent of the position of the head. The latter rule was proved by case 9.

3. As a last aid one has the combination of nystagmus with paralysis of the recurrent laryngeal nerve. This syndrome is explainable as follows: In the medulla oblongata the fibers of the vagus are in the immediate vicinity of the nuclei of the labyrinth nerve. Therefore, when these nuclei are affected by disease, it is usual for the vagus to become involved through extension of the process. Disease of the nuclei of the labyrinth nerve produces, aside from other symptoms, either nystagmus to the diseased side, or nystagmus to both sides, the condition being more marked to the diseased side. Disease of the vagus fibers produces, aside from other symptoms, a paralysis of the recurrent laryngeal nerve on the diseased side. Thus, there is a syndrome, which is characterized by a nystagmus to the diseased side and a "recurrent" paralysis on the diseased side. This syndrome was present in the following case:

CASE 10.—*History.*—F. W., a youth, aged 18, had influenza in 1920. For five years before examination he had noticed that the fingers of his right hand were bent. Since the attack of influenza he had also had dizziness on turning, disturbances in swallowing and changes in the voice.

The drum membranes were normal, as was the hearing. There was rotatory nystagmus of the third degree to the right. No Romberg sign was elicited, and there were no disturbances in coordination.

Caloric Test, Turning Test and Umbrella Test.—These tests yielded a normal result. Sensibility in the right half of the larynx was diminished. Fibrillary twitching was noted in the right half of the tongue. There was paralysis of the recurrent nerve on the right side. Spastic contraction was observed in the fingers of the right hand.

Case 10 was, as was shown also by the neurologic examination, a typical case of syringomyelia. It also revealed the disharmony between the dizziness and the nystagmus. In addition this patient gave a normal result in the examination with the revolving umbrella in spite of the intensive spontaneous labyrinthine nystagmus. Most particularly, in this case, there was seen the combination of a nystagmus to the right with a "recurrent" paralysis on the right. The difference between my two cases of syringomyelia is probably to be explained by the fact that in case 8 the fissure lay close to the midline of the medulla oblongata, while in case 10 the fissure lay in the lateral portion of the medulla oblongata. Indeed, it is known that these two sections of the medulla represent the typical localization for syringomyelia.

The cases described prove that, from spontaneous nystagmus alone, one is often enabled to draw important conclusions as to the diagnosis and the course, and therefore, also, as to the treatment, of a disease.

MALIGNANT TUMORS OF THE NASOPHARYNX*

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Malignant tumors of the nasopharynx produce such a great variety of symptoms and signs that they should be of interest not only to the otolaryngologist but to the ophthalmologist, the neurologist, the surgeon and the internist as well.

Although some of these patients first consult the otolaryngologist on account of symptoms referable to the nose and throat, many of them do not have symptoms showing involvement of the nose or throat until late in the course of the disease. For that reason, the diagnosis is often delayed, and the patient is subjected to various methods of treatment without relief from symptoms. The most prominent symptoms may be referred to the eye or the cranial nerves. Indefinite pain in the head or enlarged glands of the neck may also be present as the only symptom in the early stages of the disease.

In a review of the literature on this subject numerous individual case reports were found, but only a few large groups of cases have been reported.

In July, 1921, New [1] of the Mayo Clinic reported a group of 46 cases of malignant tumors of the nasopharynx. A second report,[2] in July, 1922, increased this number to 79 cases, and a third report,[3] in February, 1925, further increased the number to 119 cases.

In October, 1922, Woltman [4] reported a group of twenty-five cases, with involvement of the nervous system, which were selected from New's group of seventy-nine cases. He collected reports of forty-four cases from the literature. In 1923, Crowe and Baylor [5] reported fifty-two cases.

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* Submitted for publication, June 1, 1928.

* Candidate's Thesis for Membership in The American Laryngological, Rhinological and Otological Society, Washington, D. C., May, 1928.

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1. New, G. B.: The Relation of Nasopharyngeal Malignancy to Other Diagnosis, Minnesota Med. **4**:419, 1921.

2. New, G. B.: Syndrome of Malignant Tumors of the Nasopharynx, J. A. M. A. **79**:10 (July 1) 1922.

3. New, G. B.: The Treatment of Malignant Tumors of the Pharynx and Nasopharynx, Surg. Gynec. Obst. **40**:178, 1925.

4. Woltman, H. W.: Malignant Tumors of the Nasopharynx with Involvement of the Nervous System, Arch. Neurol. & Psychiat. **8**:412 (Oct.) 1922.

5. Crowe, S. J., and Baylor, J. W.: Benign and Malignant Growths of the Nasopharynx and their Treatment with Radium, Arch. Surg. **6**:429 (March) 1923.

In New's discussion on this subject, he emphasized three important facts: 1. Malignant tumors of the nasopharynx are much more common than is generally believed; 2. The syndrome which they present is not generally known, which accounts for many patients being treated medically and surgically without discovery of the tumor. 3. There is a striking lack of nasal or of nasopharyngeal symptoms in many of these cases.

In New's group of seventy-nine cases, the symptoms were referable to the eye in twenty-one; to the ear in twenty-nine; to the nose and pharynx in thirty-eight; to the glands of the neck in fifty-one; to the gasserian ganglion in four; to the jugular foramen in two and to the cranial cavity in eleven cases.

It is particularly noteworthy that of these seventy-nine patients, seventy-four operations had been performed for relief from symptoms without recognition of the fact that a primary tumor was present in the nasopharynx. In twenty-four patients the tonsils and adenoids had been removed, and in eighteen the glands of the neck; in twelve the third molars had been extracted; in nineteen, various intranasal operations had been performed and in one a mastoid operation.

In Woltman's group of twenty-five cases, nasopharyngeal symptoms were absent in sixteen cases. Pain in the face, the side of the head or the ear was noted as the most common symptom, having been the chief complaint in fourteen of the cases. In five cases, however, it was altogether lacking.

In Crowe and Baylor's group of fifty-two cases of malignant tumors of the nasopharynx, twenty-six were sarcoma; ten were lymphosarcomas and sixteen were carcinomas. In the sarcomas, nasal obstruction and involvement of the eustachian tube were the most prominent symptoms. In the lymphosarcomas, disturbed hearing, nasal obstruction and enlarged glands of the neck were the earliest symptoms. In the carcinomas, the earliest symptoms were noted as sore throat, impairment of hearing, fulness in the ear and enlargement of the glands of the neck.

In comparing this group of fifty-two cases with the group of seventy-nine cases reported by New, it is to be noted that in only a few cases of the former group was involvement of the cranial nerves recorded, while in New's report twenty-five patients had involvement of the cranial nerves. These twenty-five cases were reviewed by Woltman.

After I reviewed the cases reported in the literature, as already enumerated, and added my own personal observations in a group of twelve cases, the clinical picture became more comprehensive by a consideration of the usual location of the primary tumor, the various

structures involved by its extension into the contiguous tissues and the various symptoms and signs produced thereby.

The tumor is almost invariably located in the fossa of Rosenmüller. As it increases in size, the adjacent structures, such as the eustachian tube, the vault of the nasopharynx or the body of the sphenoid bone become invaded. It may partially or completely occupy the nasopharynx. In its extension laterally into the sphenomaxillary fossa and into the pterygopalatine fossa, a number of important structures become involved. The involvement of the lymphatic chain in the upper pharyngeal and cervical regions adds to the number of structures invaded.

All of the cranial nerves, with the exception of the eighth, may be attacked. It is probable that the first six nerves are invaded by the tumor and the remaining nerves are involved through metastasis in adjacent lymphatics.

The sixth nerve is most commonly affected (it was involved in eighteen of twenty-five cases reported by Woltman) and is usually the first to show evidence of paralysis. The position of the sixth nerve in relation to the other nerves passing through the sphenoidal fissure is variable, but it usually takes the lowest position, which accounts for its frequent involvement. In 1923, Sluder[6] emphasized this anatomic variation in his article on the anatomy of the sphenoidal fissure.

Extension of the growth upward into the sphenoidal fissure and adjacent structures leads to involvement of the second, third, fourth and sixth cranial nerves. The fifth nerve, with its three divisions, and the sphenopalatine ganglion are commonly involved on account of their proximity to the origin of the growth. The seventh nerve is usually the last to become affected, since the growth must extend laterally to the region of the stylomastoid foramen.

The jugular foramen group of nerves, namely, the ninth, tenth, eleventh and twelfth, is generally involved en masse.

The symptoms may be divided into the nasal and the extranasal. In New's group, only 50 per cent of the cases presented nasal symptoms. When present, they may be manifested as bulging of the soft palate, nasal obstruction, dysphagia, hemorrhage, foul odor and taste, alterations of the nasal voice, obstruction of the eustachian tube, tinnitus and obstructive deafness.

The extranasal symptoms are extremely variable and depend on the particular structures involved. Extranasal symptoms are commonly present in the absence of nasal symptoms.

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6. Sluder, G.: Anatomy of the Sphenoidal Fissure, Ann. Otol. Rhinol. & Laryngol. **32**:1108 (Dec.) 1923.

It is particularly noteworthy that the tumor in the nasopharynx is sometimes small (0.5 cm. in diameter) and without ulceration, while the involvement of extranasal structures and cervical lymphatics is extensive.

In cases in which the tumor extends through the body of the sphenoid bone to the pituitary gland, symptoms of pituitary tumor may be exhibited. The various extranasal symptoms encountered may therefore be considered according to the cranial nerves and other adjacent structures involved.

As a result of extension to the sphenoidal fissure and orbit, the following symptoms and signs may be noted: pain in the eye, choked disk, blindness, optic atrophy, diplopia, ophthalmoplegia, exophthalmos, ptosis and narrowing of the pupil from involvement of the cervical sympathetic nerve.

Symptoms resulting from involvement of the fifth nerve are common and may simulate tumor of the gasserian ganglion. In 1921, Shelden [7] reported a group of four cases of tumor involving the gasserian ganglion. He called attention to the fact that the ganglion may sometimes be involved from tumors arising in the nasopharynx. The clinical manifestations are those of intracranial disease and may be indistinguishable from those caused by tumors arising within the cranial cavity and involving the ganglion.

The pain in the area of the fifth nerve varies in intensity and in constancy. The pain is not identical with that of tic douloureux and is not induced by the same factors. There are changes in sensibility to pain, touch and temperature.

Paralysis of the motor branch of the fifth nerve may be manifested by weakness of the muscles of the jaw. Eleven of the twenty-five cases in Woltman's group showed involvement of the fifth nerve, the motor branch being involved in six.

Involvement of the sphenopalatine ganglion produces the pain syndrome of neuralgia of the nasal ganglion, as described by Sluder; that is, pain in and around the eye, forehead and the temporal, mastoid and occipital regions and radiating down the neck, shoulders and arms.

Earache may be produced by involvement of the eustachian tube or may be a reflex pain caused by involvement of the fifth nerve, or the ninth and tenth nerves. Facial paralysis is uncommon, and the seventh nerve is usually the last of the cranial nerves to become affected.

The last four cranial nerves, or the jugular foramen group, usually become involved at the same time, on account of their proximity to each other in this region. Therefore, the Jackson syndrome is manifested by the following symptoms and signs: Dysphagia, loss of curtain

7. Shelden, W. D.: Tumors Involving the Gasserian Ganglion, J. A. M. A. **77**:700 (Aug. 27) 1921.

movement of the pharynx, pain and anesthesia in the base of the tongue, loss of taste in the posterior third of the tongue, reflex pain in the ear, abolition of reflex excitement of the pharynx, paralysis of the vocal cords, sometimes slowing but most often acceleration of the pulse, paralysis of the palate, anesthesia of the pharynx, larynx and external auditory canal, sometimes slowing and sometimes acceleration of breathing, paralysis of the sternomastoid and trapezius muscles and paralysis of the tongue.

Other symptoms of note are ankylosis of the jaw from involvement of the pterygoid muscles, extensive metastasis to the cervical glands and sometimes systemic metastasis.

In reviewing the pathologic observations made in the groups of cases reported in the literature, it seems generally agreed that malignant tumors of the nasopharynx show a high degree of malignancy. There is a striking lack of cellular differentiation. Flat pavement characters, spines, hornification and pearl formation were regularly absent.

In New's group of seventy-nine cases, pathologic reports were made in seventy-four cases. There were thirty-four epitheliomas, thirty-three lymphosarcomas and five unclassified tumors. Of Woltman's group, fifteen were epitheliomas and ten were sarcomas.

In their report on benign and malignant tumors of the nasopharynx, Crowe and Baylor recorded twenty-six sarcomas, ten lymphosarcomas and sixteen carcinomas and pointed out the difficulties in the histologic differentiation of sarcoma and carcinoma.

In 1926, Singer [8] published a detailed report on the pathologic anatomy of malignant tumors of the nasopharynx. His material consisted of 5 cases selected from 7,051 autopsies. There was 1 case of sarcoma, 2 of carcinoma and 2 of unclassified type. He emphasized the striking lack of differentiation and difficulty of exact classification. He refers to areas of epithelial arrangement and areas of sarcomatous arrangement in the same tumor. He referred to the work of Schminke, who described a lympho-epithelial tumor, showing a network of syncitium of epithelial cells with lymphocytes in the retiform spaces.

Derigs also described a lympho-epithelial type of carcinoma. Ghon and Roman described a lymphadenoid sarcoma. Singer suggested the highly probable origin of nasopharyngeal tumors from embryonal tissue because the unripe tumor cells show a striking embryonal nature.

An article recently published by Quick and Cutler [9] on transitional cell epidermoid carcinoma is interesting and points out many features which are worthy of consideration as also applying to nasopharyngeal

8. Singer, L.: Zur Pathologischen Anatomie der Malignen Geschwlste im Nasenrachenraum, Ztschr. f. Hals-, Nasen- u. Ohrenh. **17**:368, 1927.

9. Quick, D., and Cutler, M.: Transitional Cell Epidermoid Carcinoma, Surg. Gynec. Obst. **45**:320, 1927.

tumors. Their material for study consisted of forty cases of intra-oral carcinoma with cervical metastasis, two of which were nasopharyngeal tumors.

Sections of the primary lesion and the cervical nodes were made. The authors showed that these tumors display an unusual susceptibility to radiation and present peculiar histologic features. The cells lacked the usual features of squamous carcinoma, presented transitional characters and were designated by the term transitional cell epidermoid carcinoma. The tumors were found to be highly cellular. The cells were small and uniform in size and had large hyperchromatic nuclei and scanty cytoplasm, growing diffusely, sometimes forming solid cords. Squamous characters, such as hornification, spines and pearl formation were absent. These tumors are believed to originate from transitional epithelial cells or from squamous epithelium which has lost its adult epithelial characters and has assumed anaplastic features. One of the most characteristic properties of this type of tumor is its marked radiosensitivity, which differentiates it from the radioresistant squamous carcinoma.

When the appearances of the primary lesion in the twelve cases which have been observed in this series are reviewed, certain features were presented which are worthy of consideration. In the majority of the cases, the lesions were small—from 0.5 to 2 cm. in diameter. In most instances, they were not ulcerated but presented evidence of superficial erosion. Everything seemed to indicate that the tumor had originated beneath the mucous membrane. Extensive cervical metastasis and involvement of the cranial nerves were noted in cases in which the primary lesion was small.

In most of the large tumors, frank ulceration was present and considerable necrosis had taken place. In one instance, however, a large carcinoma completely filling the nasopharynx did not show any ulceration.

Of the twelve cases, two were of lymphosarcoma and ten of carcinoma. The carcinomas showed a striking lack of differentiation. Pearl formation, spines and hornification as found in squamous cell epithelioma were absent. The cells were small, having large nuclei and little cytoplasm. Mitotic figures were numerous. The intercellular substance was scanty, but in some instances there was a great deal of lymphocytic infiltration. In some areas, the cells were elongated, presenting the characteristics of sarcoma. Sometimes the cells were arranged in groups or in long solid chains. In one case, the tissue showed embryonal characteristics. In the cellular tumors, areas of degeneration were noted. In contrast to this some sections showed the tumor cells infiltrating into connective tissues with an absence of degeneration.

In general, it may be said that these tumors presented highly malignant characteristics. The cells appeared immature and rapidly growing. Exact classification was, on the whole, difficult.

The treatment of persons with malignant tumors of the nasopharynx is palliative. The application of radium to the primary growth and x-ray and radium to the regional lymph nodes will produce temporary improvement. The response to irradiation depends on the type of tumor. Some seem more radiosensitive than others. The growth in the nasopharynx may completely disappear, but the portion of it which has usually extended into the sphenomaxillary fossa is difficult to reach with radiation. These cases all have a fatal termination, the length of life depending on the degree of malignancy, the structures involved and the response to treatment.

CONCLUSIONS

The early diagnosis of malignant tumors of the nasopharynx is often difficult on account of the small size of the primary growth and the lack of nasopharyngeal symptoms. Extranasal symptoms are commonly present in the early stages of the disease. The early signs and symptoms are usually pain in the eye, forehead, side of the face and temporal region, toothache, earache, deafness, tinnitus, sense of fulness in the ear, diplopia, blindness, proptosis, paresthesia of the face, enlarged cervical glands, dysphagia, aphonia, hoarseness and distant metastases.

The cranial nerves are usually involved extracranially. Those passing through the sphenoidal fissure are affected most commonly, particularly the sixth nerve. The fifth nerve is next most commonly involved.

The nasopharynx should always be most carefully examined in all patients with unexplained palsy or irritation of the cranial nerves, in patients with enlargement of the cervical glands and in those with metastatic malignant disease in which an apparent primary lesion is not present.

Pathologically malignant tumors of the nasopharynx present a highly malignant type of lesion with a striking lack of cellular differentiation and offer difficulties of exact classification.

The treatment consists in the application of radium and x-ray therapy.

The prognosis is grave.

REPORT OF CASES

Of the group of twelve cases observed, four have been selected for presentation in detail. The clinical picture was dominated by the extranasal symptoms, and in none of them were nasopharyngeal symptoms present.

They represent the type of cases in which diagnosis is not easy, unless one is searching for this particular type of lesion.

CASE 1.—*History.*—A colored man, aged 39, was seen in the dispensary on July 25, 1925, complaining of hoarseness, difficulty in swallowing, pain and deafness in the left ear. These symptoms had been present for two months. He had been previously treated in the clinic for cystitis and syphilis.

Examination of the larynx showed a complete paralysis of the left vocal cord, anesthesia of the left half of the larynx and partial paralysis of the soft palate, pharyngeal constrictors and tongue on the left side. The nasopharynx showed a small grayish colored growth about 0.5 cm. in diameter in Rosenmüller's fossa on the left side. The left ear drum was normal, but a mild conduction type of deafness was present. In the upper deep cervical region on the left side behind the angle of the jaw an indefinite thickening but no definite gland was found.

Neurologic examination gave negative results except for paralysis of the cranial nerves as mentioned. The eyes were normal.

The patient was again examined two months later. A mass of hard, immovable glands was present in the upper deep cervical region on the left side. A small nodule was present in the skin over the triceps muscle of the left arm. Complete paralysis of the ninth, tenth, eleventh and twelfth cranial nerves was found. The tumor in the nasopharynx increased to about 1 cm. in diameter. It was grayish and nonulcerated. A piece of it was removed for diagnosis, and it proved to be carcinoma.

The nasopharynx was treated with 500 mg. hours of radium, and deep x-ray therapy was applied to the neck. This did not prevent the progress of the lesion. Within the following month, the patient developed blindness in the left eye, with complete ophthalmoplegia and paralysis of the fifth, seventh, ninth, tenth, eleventh and twelfth cranial nerves. He died about two months later.

Comment.—Symptoms on the nose and pharynx were not present in this case. When the primary growth was discovered, it was small (less than 0.5 cm. in diameter), while the paralysis of the ninth and tenth cranial nerves was complete. This case emphasizes the importance of examination of the nasopharynx of persons with paralysis of the cranial nerves.

CASE 2.—*History.*—C. C. M., a white man, aged 54, was seen by a general surgeon on June 7, 1924, because of enlarged glands of the neck, which had been present for about a year. The tonsils had been removed previously without causing any change in the condition of the glands.

A tentative diagnosis of Hodgkin's disease was made. Symptoms in the nose, throat or ear were not present. A gland was removed for diagnosis, and the pathologic report was as follows: lymphoid proliferation, with thickening of the capsule and an increase of connective tissue, with an occasional rather large cell, which was, no doubt, endothelial. The diagnosis was probably Hodgkin's disease. The glands were subjected to intense x-ray therapy, and they gradually disappeared.

The patient was then free from symptoms for several months. On Aug. 29, 1925, fourteen months after the gland had been removed for diagnosis, he was referred to me for the first time on account of earache, deafness and nasal discharge on the left side. These symptoms had been present for about four months. He also had pain in and around the left eye, which radiated to the temporal region. The pain in the ear was aggravated by movements of the jaw. He was unable to sleep on account of pain. The left side of the neck felt stiff, and movements of the head were limited.

Examination of the nose showed purulent crusts in the posterior part of the left side. The entire left side of the nasopharynx was ulcerated and covered with a crust. There was a great deal of scar tissue along the lower border of the ulcer, which probably resulted from the x-ray therapy. The eustachian tube could not be identified. Glands were not palpable in the neck, but the upper deep cervical region on the left side was markedly thickened. The left ear drum was retracted, and some conduction deafness was present. Tissue was taken from the ulceration but was unsatisfactory for examination. On the basis of the ulceration in the nasopharynx and the history of the enlarged glands, a tentative diagnosis of primary lymphosarcoma of the nasopharynx was made.

The patient returned six weeks later, complaining of more severe earache, pain in the eye and double vision. The examination of the eye showed paralysis of the sixth nerve. The ulceration in the nasopharynx had not changed. There was a slight paralysis of the pharyngeal constrictors and the soft palate. The nasopharynx was treated with radium (400 mg. hours). During the next two months, the pain in the eye and ear was greatly relieved.

Three weeks later, the patient returned complaining of pain in the left temporal and parietal regions, sensory disturbances in the second and third divisions of the fifth nerve and difficulty in swallowing. The paresis of the soft palate and pharynx had become more marked, and partial paralysis of the left side of the tongue appeared. The larynx was normal.

One month later, pain in the temporal region and the left eye was severe. The fifth, sixth, ninth, tenth, eleventh and twelfth cranial nerves were now involved. X-ray and radium treatment did not stop the progress of the disease, and the patient died about two months later. The gland which had been removed from the neck was resectioned, and a diagnosis of lymphosarcoma was made.

Comment.—Primarily, the patient did not show symptoms in the ear, nose or throat, and sought treatment for enlarged glands of the neck. This case illustrates the importance of early examination of the nasopharynx in all patients with enlarged glands of the neck.

CASE 3.—*History.*—J. R. G., a white man, aged 53 years, was seen in consultation with Dr. Sachs on March 29, 1926. His illness had begun fourteen months previously with double vision, pain in the left eye and forehead and toothache in the teeth of the left upper jaw. Several teeth had been extracted, and an operation had been performed on the nose, without relief. The pain in the eye was described as smarting or burning. The pain in the forehead was dull and constant. Five months before, he began to have pain in the back of the head and down the left side of the neck. He also had some slight dizziness, and he said that his head felt heavy.

Three months before he entered the hospital, he began to have a dull earache and ringing in the left ear and a sensation of numbness along the zygoma. A lump in the left side of the neck had been noted for two or three months. Symptoms were not present in the nose or throat. Examination of the eye showed paralysis of the left external rectus. Slight general contraction of the visual fields was present; the fundus was normal.

Examination of the fifth nerve showed hypalgesia of the second and third divisions of the left side. The temperature sense was diminished.

On the left side of the neck, just behind the middle of the sternomastoid muscle, there was a hard, fixed gland about 6 cm. in diameter. On the left lateral wall of the nasopharynx, in the fossa of Rosenmüller, a small growth or bulging of the wall, about 1 cm. in diameter, was present.

The neurologic examination gave negative results. The Wassermann reactions with the blood and spinal fluid were negative. A stereoscopic x-ray of the skull was negative.

A section of the tumor in the nasopharynx was removed for diagnosis and found to be carcinoma.

The tumor in the nasopharynx was treated with radium (400 mg. hours). Two months later, there was no evidence of it in the nasopharynx.

During the subsequent eighteen months, this patient was kept under close observation. The gradual involvement of the orbit and cranial nerves was noted. About two months after he came under my observation, examination of the eye showed complete ophthalmoplegia, beginning optic atrophy and slight exophthalmos. The second and third divisions of the fifth nerve and the motor branch were completely paralyzed.

About a year later, a paralysis of the jugular foramen group of nerves began and was complete within a few months' time. The facial nerve was paralyzed.

At the time of his death in September, 1927, all the cranial nerves with the exception of the eighth nerve were paralyzed on the left side.

Repeated treatment of the glands in the neck with x-ray was instituted but did not stop the progress of the lesion. The growth in the nasopharynx, however, never recurred.

Comment.—At the onset of the patient's illness, the only symptoms present were headache and toothache. An operation had been performed on the nose, and several teeth had been removed from the left upper jaw. When he came under my observation, the presence of the nasopharyngeal tumor was suggested on the basis of the symptoms in the ear, paralysis of the sixth nerve, disturbance in the fifth nerve and a malignant gland in the neck. Symptoms in the nose or nasopharynx were not present.

The disappearance of the primary tumor after the application of radium proved that it was radiosensitive. The failure to prevent the progressive involvement of the glandular chain in the sphenomaxillary fossa with x-ray therapy was due to the fact that this region is almost inaccessible.

CASE 4.—*History.*—A. B., a white man, aged 44, entered Barnes Hospital on July 15, 1927, complaining of severe headaches which had been present for four months. He also complained of his tongue being "thick" and attacks of pain in the eye with radiation to the occipital regions. About six weeks previously, double vision had appeared, and there was also a sense of fulness and impaired hearing in the left ear.

The patient appeared drowsy and at times incoherent. His speech was slightly impaired. He held his hand over one eye to relieve the double vision.

Physical Examination.—The patient was poorly nourished and somewhat emaciated. Bilateral paralysis of the sixth nerve was present. The right half of the tongue was partially paralyzed. The eyegrounds were normal. A small hard gland was present in the upper left cervical region. Neurologic examination gave negative results. The examination of the ear, nose and throat showed a slight conduction deafness in the left ear. In the vault of the nasopharynx, there was a small crust, beneath which a superficial erosion of the mucous membrane was noted. This was more marked on the left side than on the right side. In the upper part of Rosenmüller's fossa, on the left side, a small mass about the size of a pea was noted on the border of the erosion.

The nasopharynx was difficult to examine, as the patient cooperated poorly. A definite tumor was not present, and a diagnosis of malignant disease of the nasopharynx did not seem warranted.

The neurologic surgeon performed bilateral ventricle puncture and explored the region of the right temporal lobe. Nothing of significance was found.

It was decided to remove the gland in the left side of the neck for examination. This was done, and microscopic examination showed carcinoma. Then a biopsy specimen was taken from the area in the nasopharynx. This proved to be carcinoma.

The nasopharynx was treated with radium (400 mg. hours), and both sides of the neck were treated with deep x-ray irradiation. The patient returned home and has not yet returned for observation.

Comment.—The paralysis of the sixth nerve and of the twelfth nerve on the right side, together with the headache and mental symptoms, suggested an intracranial lesion. The condition in the nasopharynx and the small gland in the neck did not seem to indicate a malignant disease of the nasopharynx.

This case illustrates the difficulties sometimes encountered in making a diagnosis.

A COMPARATIVE STUDY OF CHRONIC SINUSITIS

WITH END-RESULTS FOLLOWING INTRANASAL OPERATIONS*

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I shall present a study of a group of cases of chronic sinusitis limited to cases of (1) chronic suppurative sinusitis; (2) chronic hyperplastic ethmoiditis, and (3) polypoid degeneration of the mucosa. In the cases presented, the ethmoids were involved alone or together with one or more of the other sinuses; therefore, chronic empyema of the maxillary sinus per se is not included in this group.

The studies of the cases are made in the following order: (1) the chief complaint; (2) history; (3) clinical inspection—direct and indirect view with the nasopharyngoscope; (4) transillumination; (5) x-ray and laboratory work when indicated. In many cases, the examination is not complete without a visual acuity test, an examination of the fundus and an examination of the visual field. Sometimes, the complaint, history, examination and other results check, but many times they do not. It is fortunate when all the observations check up, for then there is no doubt as to the diagnosis. Sometimes the complaint and history point to nothing but infection, the nose appearing to be in good condition, but transillumination and the x-ray reveal a diseased antrum. In some cases, the diagnosis may be so difficult that it is unwise to attempt to make it after one examination.

In my experience, x-ray examinations usually confirm what has already been found, but sometimes they reveal the unexpected. The question has been raised whether a diagnosis should be made on the basis of the roentgenograms. As a rule, I do not think so, although in some cases the diagnosis is quite evident. Good stereoscopic roentgenograms reveal a great deal and often are of great value in determining what should be done. Roentgenograms in which the soft tissue has not been blotted out will show thickening of the mucosa and also hyperplasia of the bony septums of the ethmoids. Much suppuration usually causes marked cloudiness of the paranasal cells.

DIAGNOSIS

At first, one might think it easy to place any one of the chronic conditions mentioned under one of these headings, but in some cases one is often puzzled which diagnosis to make, as there is evidence of

* Submitted for publication, July 1, 1928.

* Read before the Section on Laryngology, Otology and Rhinology at the Seventy-Ninth Annual Session of the American Medical Association, Minneapolis, June 14, 1928.

both suppuration and hyperplasia, or of suppuration and polypoid degeneration. The number of cases I have put under each heading therefore, may not be exactly correct, but they are as nearly so as I could place them. Statistics are often undependable, but if one does not use them as mathematically exact and draws conclusions from them taken together with other information and facts that lend color to the subject, valuable information can often be obtained. When pus is present in great quantity, the diagnosis of chronic suppuration is made.

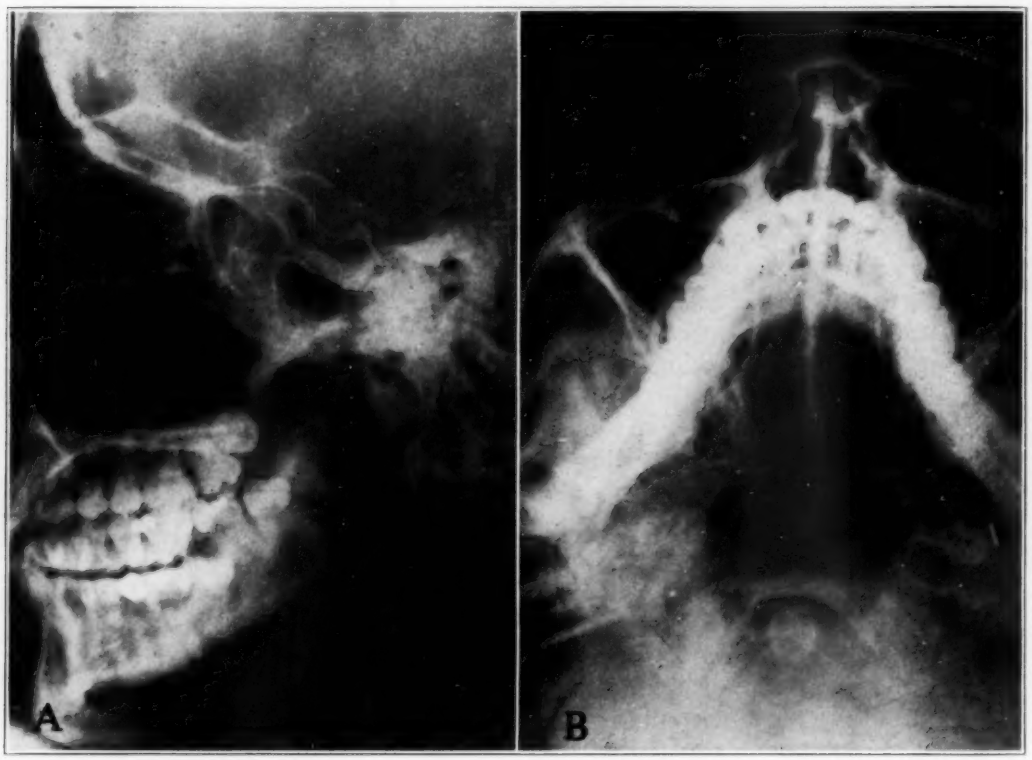

Fig. 1.—*A*, lateral view; *B*, vertex chin position; showing haziness of left sphenoid.

In some cases of hyperplasia and polypoid degeneration more or less pus is present during colds.

The symptoms are many, consisting of nasal blocking, slight discomfort about the nose and head, discharge varying from a small to a large amount, severe headache, general debility, rheumatism and others.

Chronic suppurative sinusitis is usually easily diagnosed. There is a history of acute infectious disease, a bad cold that never cleared up

or an infection coming from the teeth. Occasionally, it has been preceded by an injury to the nose. The chief symptoms are a purulent nasal discharge, pus dropping into the throat (clearing out the nasopharynx), stuffiness of the sides affected, usually headache and frequently general malaise. I have had five or six men patients who complained of sexual impotency, which was restored after the operation. Olfactory sense may be impaired. Clinical examinations usually reveal pus in the nose, edema and congestion of the mucosa in

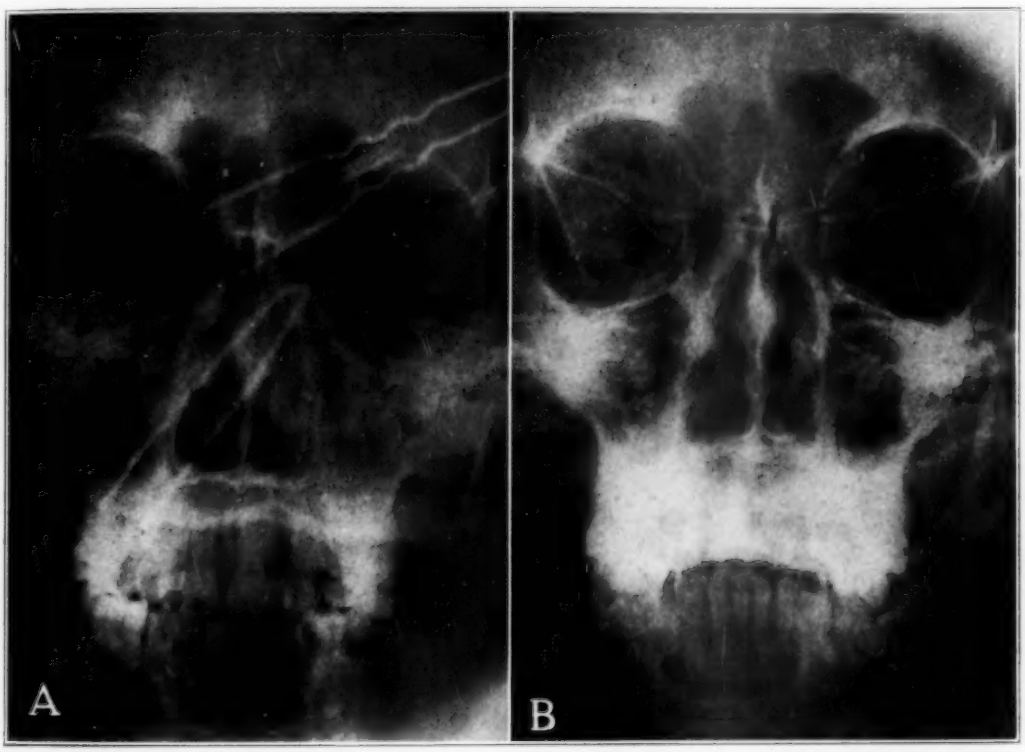

Fig. 2.—Chronic suppuration. Patient was thought to have tuberculosis and pellagra; *A*, before operation; *B*, nine months after operation. Condition in head improved from 75 to 90 per cent.

the region from which the pus is coming. Transillumination is greatly diminished. Roentgenograms show cloudiness of the sinuses involved.

Chronic hyperplasia may be easy to diagnose, but sometimes it is most difficult. Headache usually is present, and often the nasal ganglion syndrome complex. The headache may be frontal, temporal, occipital or all three combined. The vaccuum frontal headache is more often found in this condition, and the Ewing sign is present. The patient frequently complains of soreness back of the eyeballs. There may be a

stuffy feeling in the nose and mucus, bloody mucus or watery discharge. There is frequently a history of recurrent watery colds with sneezing. The patients are likely to be of a nervous temperament and below par. Transitory painful conical nodes occur on the scalp in some cases. Tenderness and soreness of scalp may be present. The digestive apparatus is sometimes affected, as shown in cases in which pain has been relieved by an operation on the septum, after which the patient has gained in weight and vitality. Backache is not infrequent. Many

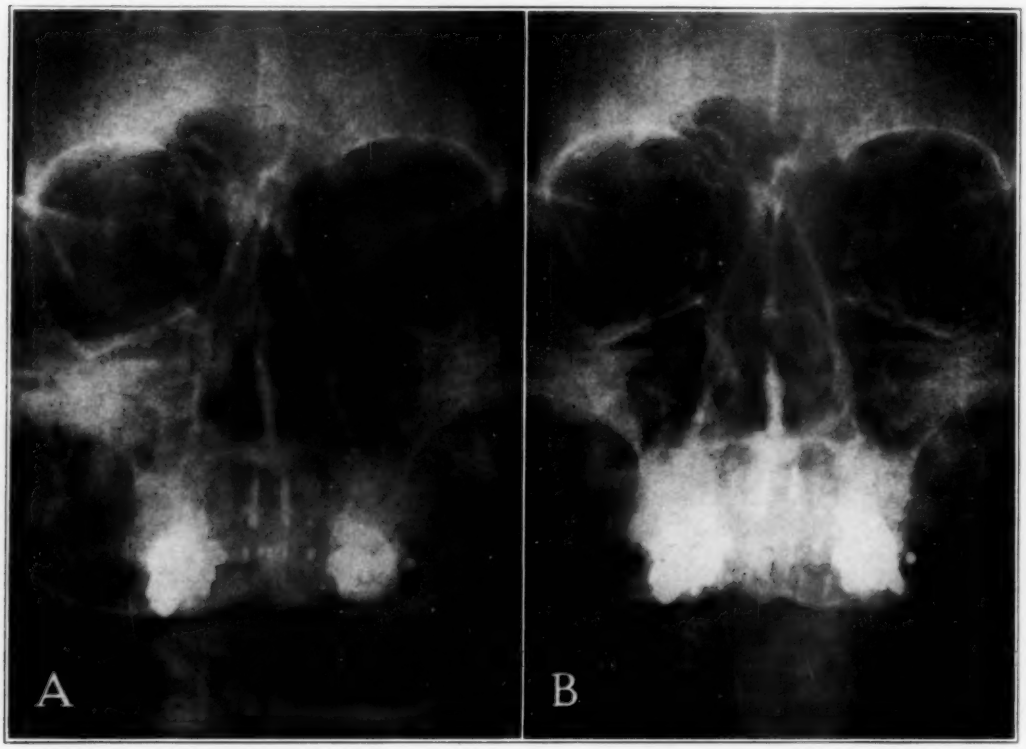

Fig. 3.—Chronic suppuration. *A*, before operation; *B*, nine months later; patient cured.

of the symptoms are also present in chronic suppurative sinusitis. On examination, one usually finds the mucosa moderately congested, with some thickening. There is usually an overgrowth of the bony turbinals. A watery or mucus secretion may be present, but seldom pus. The results of transillumination of the frontal sinuses are usually negative, while the maxillary sinuses may be less transparent. Roentgenograms usually show some haziness of the ethmoids with hyperplasia of the bony septums and some haziness of the maxillary sinuses.

Symptoms of polypoid degeneration are nasal blocking, watery or mucous discharge and often sneezing. Impairment of the sense of smell, bronchitis and asthma are often encountered. Headache is seldom present, and, if so, is usually of minor importance. On examination one finds polypi or a thickened edematous mucosa. The pathologic changes range from a slight edema of the mucosa to the formation of polypi. The mucosa is usually paler than normal. Transillumination of the antrums is not likely to be clear. The frontal sinuses may be clear. Roentgenograms show haziness due to thickened tissue.

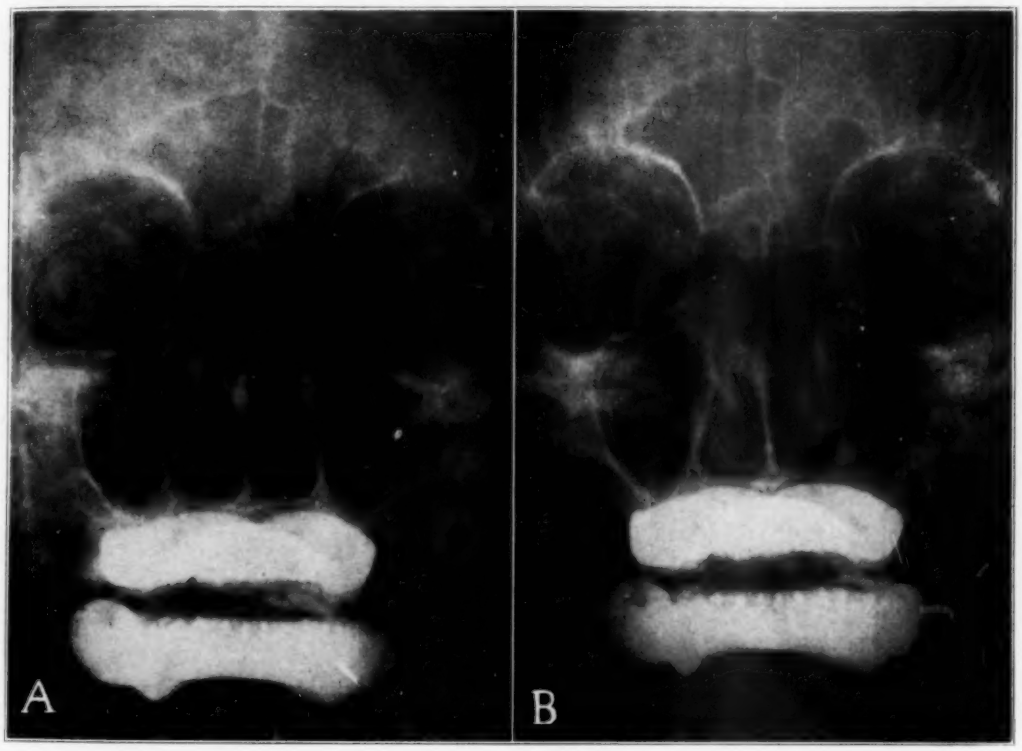

Fig. 4.—Chronic hyperplastic ethmoiditis, with vacuum frontal headache. *A*, before operation, showing hyperplasia of the ethmoidal septums. *B*, six months after operation; the overhang left to preserve the sense of smell should be noted.

ETIOLOGY

As to the etiology, it is agreed that infection is the cause of chronic suppuration. Abnormality of the nasal passage may be an indirect cause. I wish to call attention to the fact that chronic suppuration is most frequently seen on the concave side of the septum. I suspect that nature's efforts to fill in this space with soft tissue blocked

the ostia, prevented free ventilation and favored infection. The etiology in chronic hyperplasia is not so simple. This condition is probably due in some cases to irritants in the inspired air (Hajek), to a low grade local infection, to a toxin circulating in the blood streams or to a metabolic disturbance. The etiology of polypoid degeneration is also not so clearly understood as I should like. I do not doubt that recurrent local infection is the chief cause in most cases, while in other

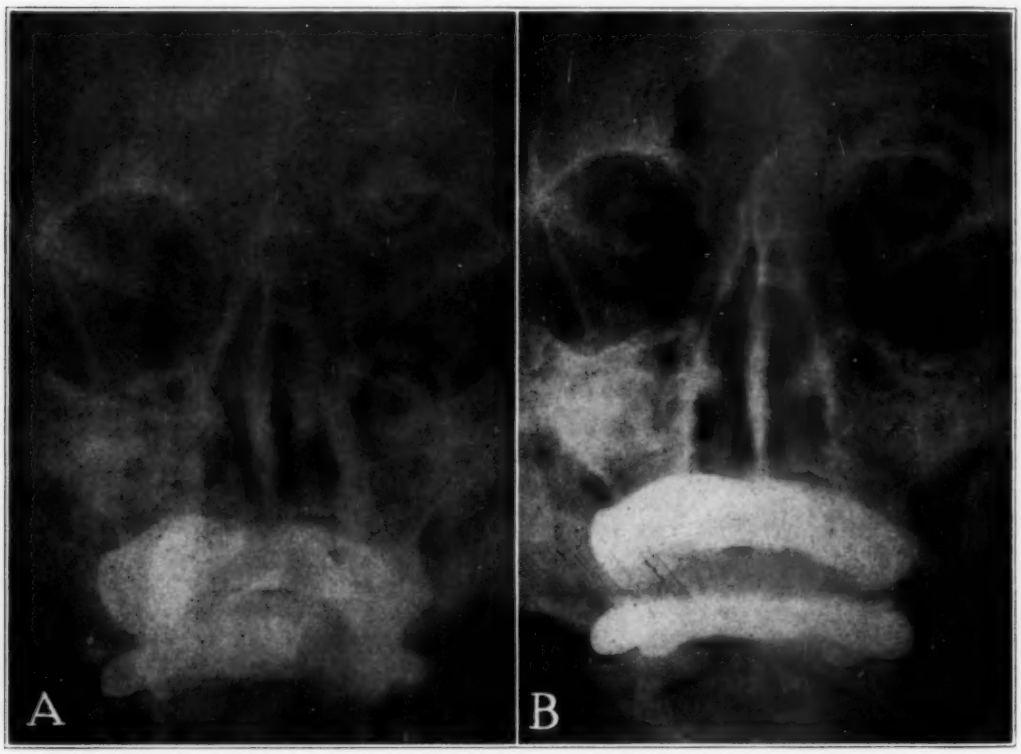

Fig. 5.—Patient gave history of difficult nasal breathing, watery and mucus discharge for several years, blurring of vision, double vision and spots before the eyes for two or three months. Examination revealed polypoid degeneration of the ethmoids and involvement of both maxillaries. Examination of the eyes revealed: bilateral choked disk of 4 diopters; retinal hemorrhages; vision, right 20/40, left 20/50; visual fields for white, red and green much contracted. Paralysis of left external rectus. All sinuses were opened in January, 1928. Vision began to improve immediately, and double vision soon cleared up. In May, 1928, vision in each eye was 20/20. Slight atrophy of nerves. Nose in good condition. Patient feeling fine. *A*, before operation; *B*, four months later.

cases the infection is invited by preceding changes of the mucosa. The frequency with which this condition is associated with bronchial asthma and hay-fever is an indication that an allergic reaction plays a large

part. The frequent coincidence of bronchial asthma is due to the fact that the bronchi and nasal mucosa depend on a common vasomotor neurosis. It is probable that bronchial râles in cases of polypoid degeneration are largely due to the mucous glands being stimulated by the sympathetic nerves, while in the case of chronic suppuration there is a secondary infection of the bronchi from the sinuses.

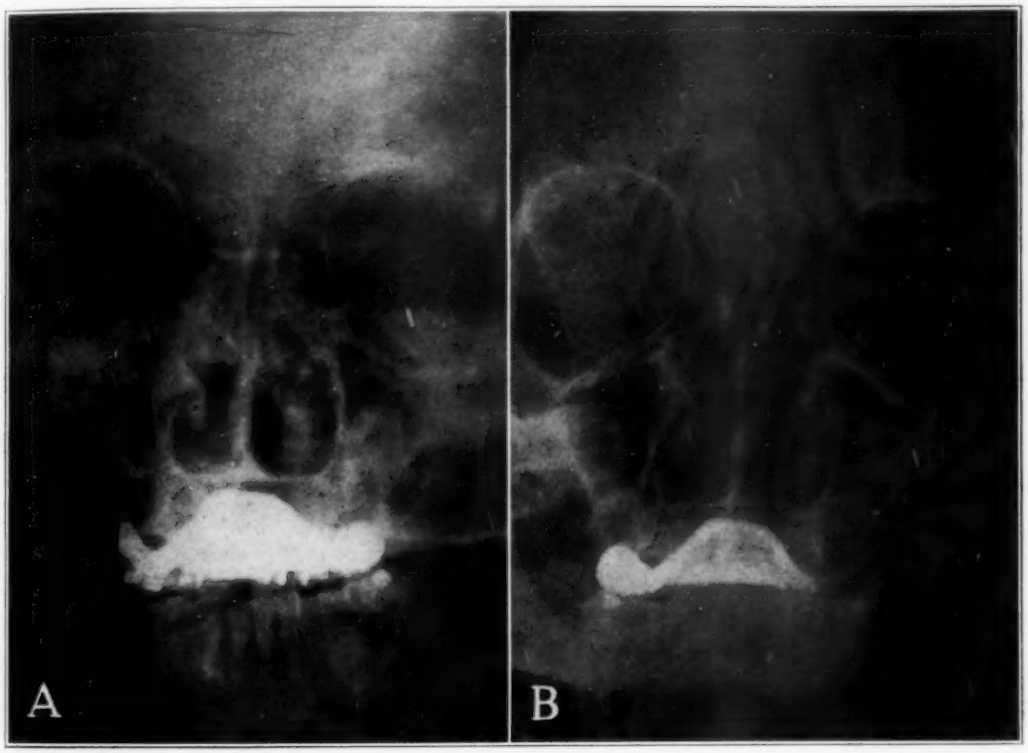

Fig. 6.—Polypoid degeneration (polypi) of ethmoid. Pus in maxillaries. *A*, before operation; *B*, four years after operation; patient cured.

TREATMENT

After a diagnosis has been made, the question arises as to how the case can best be handled. As a rule, I employ treatment in my cases before operating. In severe suppurative cases, the condition often improves, so that the operation can be done with less bleeding and quicker after-results. Milder cases may clear up. In cases of hyperplasia, the pain may be greatly relieved and operation may be avoided. It is probable that ventilation is reestablished. In cases of polypoid degeneration, this may be of some advantage, but I doubt that it will ever effect a cure.

There are other advantages in treating the patients before operating. 1. It gives one an opportunity to study the patient as well as the disease. 2. The patient has an opportunity to study the physician and learn of his interest in the patient. The greater the confidence of the patient in the surgeon, the less is the toxic effect from the local anesthetic and the less the shock following the operation.

After deciding that an operation is necessary, it has been my policy to choose the intranasal technic under local anesthesia. I think the results obtained justify this procedure. Harold L. Lillie reported a series of sixty cases of suppurative frontal sinusitis with external manifestations, in which 31.6 per cent cleared up following intranasal operation.[1] His success would certainly justify one's trying the intra-

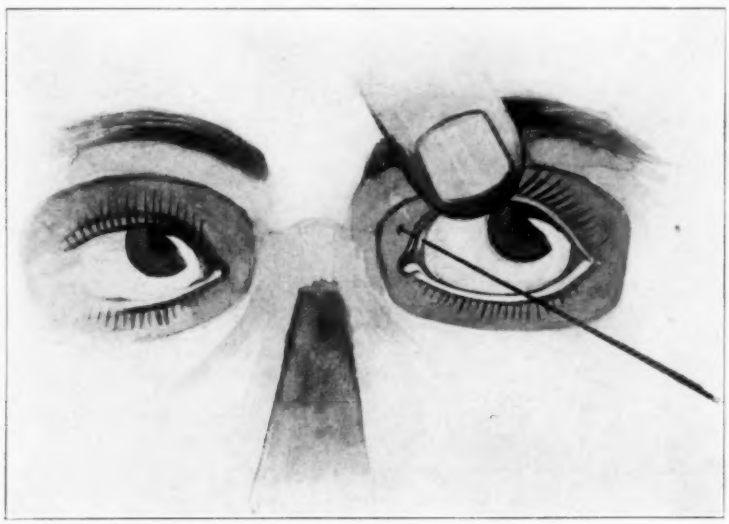

Fig. 7.—Blocking of nasal nerve through the orbit.

nasal route first when there are no external manifestations. Should the intranasal operation fail, the external one can be done later and more easily.

I prefer local anesthesia for the following reasons: (1) there is less shock following the operation; (2) there is less bleeding, giving better visibility; (3) there is less danger to the patient. If one uses a local anesthetic, it is essential that a good anesthesia be obtained. Until recently, it was my policy to pack the side on which operation was to be performed with cotton pledgets saturated with 10 per cent cocaine solution and epinephrine hydrochloride. I now use a combination

1. Lillie, H. I.: The Two Stage Operation for Suppurative Frontal Sinusitis with External Manifestations, Arch. Otolaryng. **5**:152 (Feb.) 1927.

solution of 0.5 per cent butyn and 1 per cent ephredrine, to which I add epinephrine hydrochloride just as I did to cocaine in the foregoing solution.[2] The purpose of this is to check the bleeding as well as to add to the anesthesia, and it is placed in the nose about twenty or thirty minutes before the operation. Morphine, ⅛ to ¼ grain (0.008 to 0.016 Gm.), with 1/150 grain (0.43 mg.) atropine, is given hypodermically about the same time. Before beginning the operation, I inject about 2 cc. of 1 per cent procaine (to which I add one drop of epinephrine hydrochloride to every 2 cc. of solution) through the posterior palatine canal infiltrating around the nasal ganglion. I formerly made the injection in the nasal nerve through the orbit at the anterior ethmoidal foramen.[3] The two injections practically block sensation on that side of the nose. It is not now my custom to block the nasal nerves except in severe suppurative cases. I infiltrate the tissue with about 1.5 cc. of the procaine solution just in front of the anterior end of the middle turbinal. Some of the solution infiltrates into the anterior ethmoid. I also make an injection in the anterior end of the inferior turbinal and the antrum wall in the inferior meatus. There is still some sensation left, which is of great importance, along the cribriform plate and the roof of the anterior ethmoid cells about the infundibulum. These areas are supplied by nerves through the posterior and anterior ethmoidal foramen which have not been blocked. These areas of sensation serve to give danger signals, and the patient will warn that they are close-by. If the patient has pain during the operation, one should apply the butyn and ephredrine or cocaine solution topically to the area of pain.

Indications of shock during or following the operation are exceedingly rare. I attribute this to thorough anesthesia and a concomitant understanding between the patient and the operator. It is necessary to know the patient as well as the disease in order to be a successful local operator. I might add further that the patient is more important than the removal of the pathologic condition.

Operation.—The object of the intranasal operation is to establish ventilation and drainage, and it is well to remember that adequate drainage will not take place until ventilation is established. It will not be necessary to give all the details of the operation. My policy is to open the antrum first, because it is better anesthetized at this time. I take a submucus elevator and a heavy Hartman's forceps and lift the inferior turbinal upward and inward, producing a fair exposure of the inferior meatus. I then enter the antrum with an antrum rasp, making a sufficiently large opening for the use of the large antrum punch of Dr. W. P. Reaves. The punch cuts on all sides and enables one to remove most of the inferior meatal wall. The edge is then smoothed off with the rasp, which

2. Reaves, R. G.: Combined Use of Butyn and Ephedrin, Clin. Med. & Surg. **35**:49 (Jan.) 1928.

3. Reaves, R. G.: Nerve Blocking for Nasal Surgery, J. A. M. A. **74**:1514 (May 29) 1920.

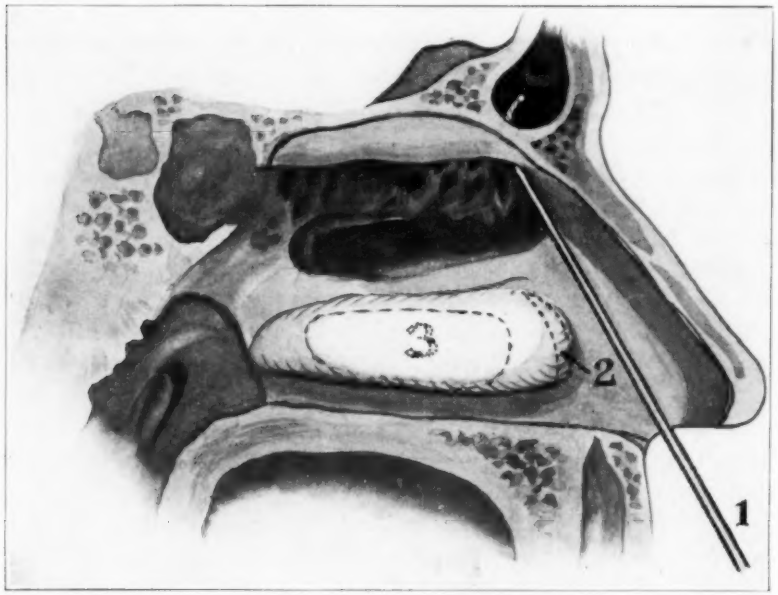

Fig. 8.—Operative technic. *1* indicates probe point frontal rasp; *2*, section to be bitten out to reduce the swelling of the anterior end of the inferior turbinal; *3*, opening into antrum; overhang to preserve the sense of smell should be noted.

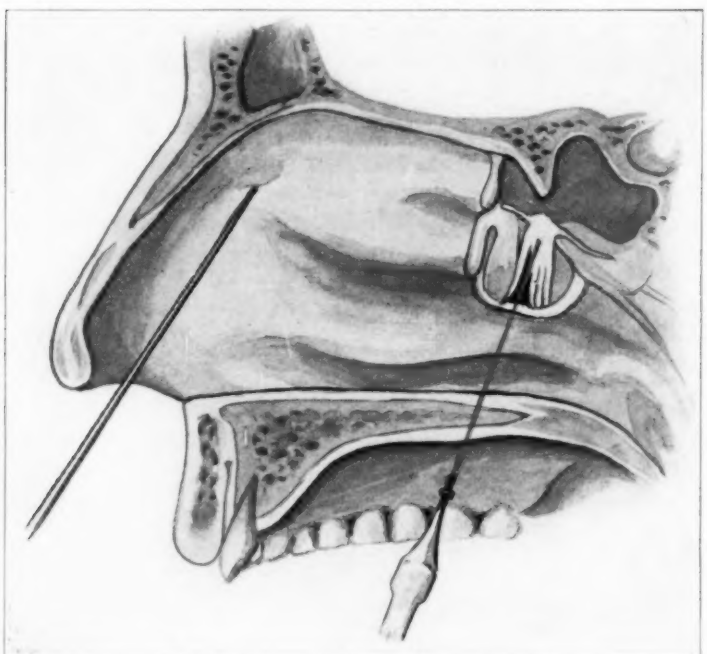

Fig. 9.—Showing infiltration point anterior to middle turbinals and blocking of nasal ganglion through the posterior palatine canal.

is small and has a limited cutting surface, so as not to injure the mucosa on the inferior turbinal. The teeth are small and sharp, having a tendency to cut rather than to tear. In some cases, it is necessary to trim the inferior turbinal in order to secure ventilation. In severe cases of empyema of the antrum, I make an opening in the middle, as well as the inferior meatus.

In cases in which the anterior end of the inferior turbinal swells against the septum and blocks the breathing, a satisfactory result can be obtained by biting out

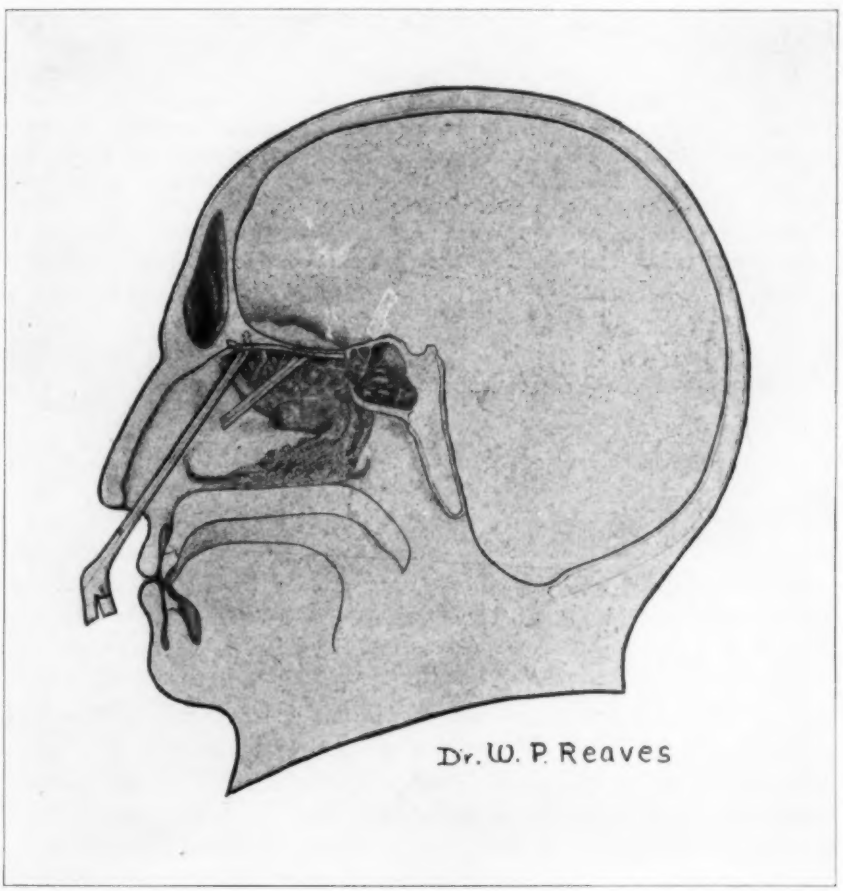

Fig. 10.—Showing Greunwald punch opening anterior ethmoids, and packing in nose to prevent drainage into throat.

a section of the turbinal close to the frontal process of the maxilla and then pressing the end of the turbinal against the maxilla, leaving only a little raw surface.

The next step is to enter the posterior ethmoid with the Sluder knife, as described in Dr. Sluder's book, partially severing the middle turbinal. The anterior half is then severed with the small turbinal forceps of Dr. W. P. Reaves, and the removal is completed with the snare. Caution is taken to leave enough of the overhang to preserve the sense of smell. The posterior cells and sphenoid are now opened with suitable punches. The remaining ethmoid cells are opened up

by working forward. This step was stressed by Shea [4] in 1922. This procedure is working away from, instead of toward, the brain. On reaching the infundibulum, it is necessary to have an angle punch (Gruenwald) to open cells in this region. After having opened the anterior cells, I probe for the frontal opening, which is usually found. If the opening is large enough for ventilation, it is not disturbed, but if it is rather small, I insert my probe point frontal rasp and with gentle manipulation enlarge the opening. I then take the larger rasp and try to break down the floor of the frontal bone, but do not use the rasp on the side wall.[5] I again take the angle punch and clean out all pieces of tissue I can. The agger nasi cells should be opened up carefully. I have not mentioned the curet and do so now only to condemn it. The operation as described is similar to that described by Dr. W. P. Reaves in 1920,[6] and is intended to leave all bone covered with mucosa except where the wall of the sphenoid, ethmoidal septums and floor of the frontal bone have been bitten away. It takes only a small amount of the new growth to cover these areas, the main problem of nature being the adjustment of the newly exposed mucosa to its new surroundings.

Packing is placed in the antrum and in the posterior part of the nose against the anterior part of the sphenoid so as to prevent drainage into the throat. The packing is removed the next day.

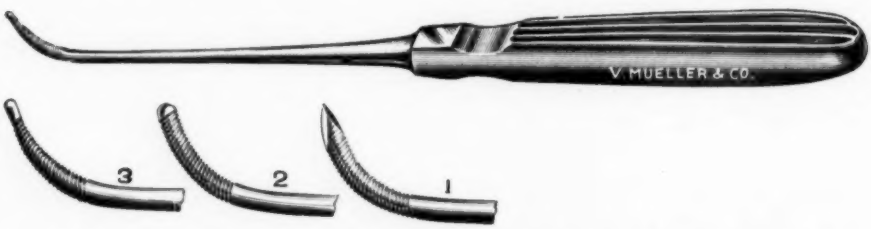

Fig. 11.—Antrum and frontal rasps used for intranasal operation; *1*, the antrum rasp; *2*, the blunt point frontal rasp; *3*, the probe point frontal rasp.

PATHOLOGIC CHANGES

I will not comment on the microscopic changes, but will refer to the work of Wright, Smith, Sluder, Hajeck and Beck, and the article by Mullin and Ball [7] in *Annals of Otology*, March, 1928. It is unfortunate that Mullin and Ball did not include the bone in their study. There are typical changes which shade off into the borderland of normal or other pathologic conditions. Keeping in mind this variation, I will

4. Shea, J. J.: A Comparative Study of Ethmoidal and Sphenoidal Operations, J. A. M. A. **79**:203 (July 22) 1922.

5. Reaves, R. G.: New Antrum and Frontal Rasps, Arch. Otolaryng. **5**:351 (April) 1927.

6. Reaves, W. P.: Ethmoidal Operations for Pan-Sinusitis, Laryngoscope **30**: 289 (May) 1920.

7. Mullin, W. V., and Ball, R. P.: Studies of Pathologic Tissue Removed from Chronically Infected Nasal and Accessory Sinuses, Ann. Otol. Rhin. & Laryng. **37**:182 (March) 1928.

attempt to describe the macroscopic changes found during the operation. As a matter of fact, the diagnoses given were made during the operation. The preoperative symptoms, the postoperative diagnosis and the end-results were put together for study.

The tissue in chronic suppuration is thickened, swollen and congested—probably better described as thickened, swollen and juicy with blood serum laden with leukocytes. In some cases the bone may be thickened, but often it is thin from partial absorption. In chronic hyperplasia the mucosa is moderately thickened and congested, and bleeds easily. There is a thickening of the ethmoidal septums and usually an overgrowth of the bony turbinals. In polypoid degeneration the mucosa is thickened, more of an edematous nature and usually paler than normal, but at times congested. The mucosa may show a moderate to extreme edema in polypi formation. The ethmoidal septums are invariably thin in these cases. In extreme cases I think it is possible that the thinning of the bone extends to the outer walls of the sphenoids and ethmoids.

The postoperative treatment is followed closely for the first week or ten days. The nose is kept clean and the operative field is painted with 2 per cent mercurochrome-220 soluble. After two or three days, when the oozing has stopped, the operative field is irradiated with the quartz ultraviolet rays. The amount of irradiation given depends on the amount of edema and bogginess of the tissue. The greater the edema and bogginess, the greater the need of irradiation. If granulations persist in forming in some part of the field, the granulations are touched up with 10 per cent silver nitrate and then the rays are applied for about three or four minutes. This usually causes the granulations to subside. This treatment has greatly shortened the after-treatment, the field soon becoming healthy, and in chronic suppuration, pus disappears in a large majority of the cases. In polypoid degeneration, the tendency to polypi formation is held back by the irradiation, and, if watched carefully, the tissue soon begins to assume a healthy condition. In the past two years, my results in treating patients with chronic suppurative sinusitis and polypoid degenerations have surpassed all expectations. About 90 per cent of the cases will clear up if ventilation is established and the proper after-treatment is given.

The chronic hyperplastic cases are, in my experience, the hardest of all in which to effect cure. This may be expected from the nature of the condition present. In many cases, I have obtained most excellent results, and I feel that I have helped a large majority of those on whom operations were performed, but some still have severe attacks of headaches. In cases in which the attacks of headache occur on the slightest congestion of the mucosa, I believe that the hyperplasia has extended into

the adjacent skull bones. As Dr. Sluder has explained, the bony canals through which the nerves pass have become smaller, and any swelling in the canals causes pressure on the nerves. I feel that worry and undue nervous strain will add to the headaches. This may be due to swelling in the canals or it may be brought about because the pathway to pain has been so thoroughly trodden that the sensation of pain is easily registered on the brain from these nerves—in other words, habit through the path of least resistance.

Results of Operations in Chronic Sinusitis

Condition*	Number† of Operations	Frontal Involvement	Maxillary Involvement	Ethmoid Involvement	Sphenoid Involvement	Noticeable Improvement	50 to 75% Improvement	75 to 99% Improvement	90% Improvement	Cured	Unknown
Chronic suppuration	57	29, or 50.9%	56, or 98%	57, or 100%	12, or 21%	..	7, or 12%	20, or 35%	6, or 10%	22, or 38%	1
Chronic hyperplasia	54	3, or 5.5%	37, or 60%	54, or 100%	5, or 9%	..	6, or 11%	17, or 31%	16, or 29%	12, or 22%	3, or 5.1%
Polypoid degeneration	39	14, or 34.1%	38, or 97%	39, or 100%	17, or 43%	2, or 5%	3, or 7.6%	5, or 12%	12, or 30%	18, or 46%	
Total	150	46	129	150	34	2	16	42	34	52	4
Percentage of total		30	86	100	22.7	1.3	10.6	28	22.6	34.6	2.6

* Outstanding complaints—Chronic suppuration; purulent nasal discharge and headache; headache may be absent and this may be noticed in cases with thin bone. Chronic hyperplasia: headache; postnasal dripping is usually complained of. Polypoid degeneration: nasal blocking, water discharge, sneezing; headache seldom present and when present is usually a minor complaint.

† Of total number of operations: not improved, 1.3 per cent; unsatisfactory, 10.6 per cent; satisfactory, 85.2 per cent.

In tabulating the operations, it was found that fifty-seven operations were performed for chronic suppuration, fifty-four for chronic hyperplasia and thirty-nine for polypoid degeneration. The table shows the number of frontal, maxillary, ethmoid and sphenoid sinuses involved under each group, and also the result in percentage. It was found that the best result was obtained in polypoid degeneration, the next in chronic suppuration and the poorest in chronic hyperplasia.

In two cases in which operation was performed the patients said that they were not benefited. In the group of patients reported as improved from 50 to 75 per cent, the results are unsatisfactory from the surgeon's standpoint, but some of the patients are grateful for the amount of relief obtained.

The group in which there was from 75 to 90 per cent improvement consists of patients well pleased and satisfied with the results, many of whom do not need to report for treatment. The group in which there was 90 per cent improvement consists of patients entirely relieved, so far as they are concerned, but whom, for some reason, I would not call cured. The group of cured patients are those without symptoms or clinical manifestation of any disease about the sinuses on which the operation was performed.

The roentgenograms taken before and after operation show a better pneumatization of the sinuses and the membrane approaching normal after the operation. In most of the patients shown, the maxillary sinuses are clear on transillumination, but roentgenograms show the membrane to be somewhat thickened. It apparently is too much to expect the membrane to return to normal after it has had an increased deposit of fibrous tissue; however, it can still function to a large extent, and this result is better than if the tissue were replaced entirely with scar tissue.

In the foregoing series of twenty-nine chronic suppurative frontal sinuses, I have had to perform three external frontal, one modified Killian and two Lynch operations, all of which have been successful. I have one patient on whom I should probably perform a Lynch operation, and I have two other patients on whom I should probably perform an external antrum operation. I have one patient in the series who permitted another physician to perform a double radical antrum operation; the results on the antrum were good but the results on the patient were most unfavorable.

CONCLUSIONS

There is a definite pathologic condition of the nasal mucosa with a tendency toward polypi formation and thin bone (rarefaction) and a fairly constant group of symptoms. The condition is confused, by some, with a true hyperplasia, so well described by Dr. Sluder. There is a difference in the mucosa, but perhaps what makes the greatest difference to the patient is the fact that in hyperplasia the bone is thick and the patient has frequent headaches, while in polypoid degeneration, the bone is thin and the patient seldom has headache. Chronic suppuration may occur in a normal nose or be superimposed on either of the foregoing conditions. The amount of headache that accompanies chronic suppuration depends on the condition of the bone.

Most cases of chronic sinusitus will clear up after ventilation and drainage have been established, the mucosa approaching or returning to the normal. In studying these cases, I have come to the conclusion that there is a definite pathologic condition.

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ABSTRACT OF DISCUSSION

DR. JOHN J. SHEA, Memphis, Tenn.: The operative procedure that is best, giving the best end-results, varies with different operators according to their experience. The fundamental principle is that the procedure which will be followed by a return of the nose to as near a normal physiologic basis as possible is the one that should be used in each case. The operation which Dr. Reaves has demonstrated is the one which in his hands has given the best results, and certainly is the one for him to use. The end-results compare favorably with those of any of us. Few patients after operation are perfectly normal in their physiology. With that as a basis the patient can be given a better idea of what he is to expect if it is explained to him what the nose can accomplish afterward—that it is not only the operation, but it is the after-care that counts.

Several years ago, Dr. Reaves demonstrated the results he was obtaining with the use of the quartz light in postoperative cases. I was skeptical, but invested in a quartz lamp and have since used it with what I think are favorable results as far as the comfort of the patient is concerned. After operation, it certainly keeps down a considerable amount of congestion, and in the chronic postoperative case in which the patient comes back every winter it gives a certain amount of relief that is of value to him whether it is a scientific improvement or not. The adult who is most disappointed is the one who expects not to have any more postnasal discharge. In these cases the postoperative care, not only immediately after the operation, but for each winter, and usually each summer after, is the important part. I am now making all my patients with chronic sinus conditions take as much sun exposure as possible during the summer months, so that the following winter their immunity to respiratory infections will be increased. For children a series of sun baths is prescribed and I think that the children who in the past have had sinus disease, and on whom I have used sun baths in the summer, had much less trouble last winter than those who did not have the sun treatment. To perform as extensive an operation as Dr. Reaves has described in his paper, of course, requires an experienced operator, and to some it may appear to be a great deal of work to be done on one patient; but there are times when we have all done as much work, and the patient has been better for it.

DR. EDWARD J. BROWN, Minneapolis: Shortly after my graduation in medicine fifty years ago, I asked Dr. Lefferts, at the old Demilt Dispensary, if he could cure nasal catarrh. He replied, "I can remove the symptoms." Dr. Lefferts and his contemporaries did little intranasal operating. We of a later generation have done much operating, and I fear too much of it has been ill advised and unnecessary. My own experience, both personal and professional, for many years has been that conservative and nonoperative treatment has been sufficient in most cases to relieve both acute and chronic disease of the sinuses. For many years, in addition to washes and vaccines, I have used intensive subjective negative pressure and the prolonged strong inhalation of beechwood creosote and eucalyptol. Since the publication of the report on the valuable antiseptic action of thymol by Harold B. Myers of Portland, Ore., I have added a 10 per cent alcoholic solution of thymol crystals. The results have been striking. A case in point was an involvement of both antrums and probably of the sphenoids and ethmoids, of many years' standing, of sufficient seriousness to have caused, as I believe, a large paracentral scotoma of one eye. Under the conservative treatment, the discharge and other symptoms became practically nil, as well as the disposition to occasional nasal colds.

DR. ROBERT G. REAVES: Of course it was impossible to cover this subject as I would like. I included three groups of cases, any one of which would provide material for a long paper. Many of the cases cleared up absolutely—there was not any sign of trouble in the nose. I sent out questionnaires, and many patients stated that the sinuses were absolutely clear. I cannot effect cure in all the cases, and no other physician can, but a lot can be done for most patients, and many can be cured if one works hard enough. I believe in being conservative. I agree with Dr. Brown concerning that. I believe in treating the patients and clearing the cases up without operation if possible; but if that were not possible and I were the patient I would prefer to have some one operate and give me a chance to get well rather than to have a condition that would not permit me to go on with my work. If treatment alone will not cure the patient, one must resort to operative measures.

THE SUBARACHNOID SPACES IN RELATION TO OTITIC MENINGITIS*

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The complication of the gravest importance which concerns the otologist is probably the invasion of the subarachnoid spaces by infecting organisms and the subsequent progressive suppurative meningitis. It is a disease of such serious consequences that any light, no matter how small, which might be shed on it may be welcomed, with the hope of a clearer illumination in the future. At best, the mortality in all varieties of septic meningitis is excessively high. It will run well over 90 per cent, and in many forms will probably be more than 95 per cent. In 1921, Eagleton[1] was able to collect reports of cure in only thirty cases of purulent meningitis following operation. It is true acute suppurative meningitis with the infecting organisms proliferating and elaborating their toxins in the subarachnoid space that demands one's attention.

The lethal effects of this invasion are due to three distinct and yet inseparably intermingled factors: (1) the poisonous effects of the toxins manufactured by the bacteria themselves, (2) the toxins generated in the tissues and the cerebrospinal fluid as a result of bacterial action on them, and (3) the mechanical effects of the pressure produced within the skull by the products of inflammation. It is a typical septic condition, progressing from the primary focus. Surgical treatment is as imperative for this complication as is this kind of treatment for the primary focus in the mastoid, the sinus or the labyrinth.

However, surgical treatment in cases of suppuration within the subarachnoid spaces is not as simple as treatment for sepsis elsewhere in the body. In most other forms of septic infection, surgical pro-

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* Submitted for publication, April 3, 1928.

* Thesis presented to the Faculty of Otolaryngology of the Graduate School of Medicine, University of Pennsylvania, in partial fulfilment of the requirements for the degree of Master of Medical Science for graduate work in otolaryngology, 1928.

* Extramural work performed at the Eye and Ear Infirmary and the City Hospital, Newark, N. J., under the preceptorship of Dr. Wells P. Eagleton.

* Read before the Eye, Ear, Nose and Throat Section, Academy of Medicine of Northern New Jersey, April 9, 1928.

1. Eagleton, W. P.: The Operative Treatment of Suppurative Meningitis with Especial Reference to Irrigation of the Cranial and Spinal Subarachnoid Spaces; and Importance of Protective Meningitis from a Prognostic and Therapeutic Standpoint. With an Analysis of the Cases of Recovery—Exclusive of Meningococcic—Reported in the Literature, Tr. Am. Otol. Soc., 1921.

cedures have secured a great diminution of mortality and a remarkable preservation of function. But in meningitis, with the exception of the epidemic forms, the mortality is nearly as high as it was before the dawn of craniospinal surgery, which has achieved such notable results in other lesions of the brain and cord.

HISTORICAL RÉSUMÉ

Surgical efforts toward the treatment of persons with meningeal infections had their beginning even as far back as the time of Percival Pott,[2] in 1760. Written a century before the bacterial origin of infection was known, his work is a remarkable exposition of the clinical picture of meningitis. He evidently made a most enthusiastic and persistent effort to prevent and cure meningeal infections following trauma by surgical measures. He advocated that all efforts at treatment should be directed toward the point of fracture from which the "putrefaction" was known to have originated. He urged the routine operative exposure and drainage of all fracture wounds and fissures as a preventive procedure. He felt that, while the methods were not revolutionary in the successes obtained, the idea might hold a promise for the future. He refers to the treatment for post-traumatic meningitis as "a very melancholy part of practice, and to render the smallest acquisition of knowledge is worth all our trouble." However, the radical surgical methods taught by Pott received scant recognition.

Subarachnoid Drainage.—In 1873, Gross,[3] writing about post-traumatic infections, urged surgical treatment for "effusion of pus into the arachnoid cavity. If a free incision is made into the dura mater so as to admit its ready escape, one-half of the patients fight their way through. The necessity of the operation is therefore not to be questioned." There was a considerable lapse of time before any one else suggested surgical intervention for "effusion of pus within the cavity."

Ventricular puncture and drainage are the next delicate procedures offered for the relief of the effusion in meningitis. The theoretical suggestion was first made in 1881 by Wernicke, and in 1888 by W. Mayo Robson,[4] who considered the ventricular tap a remedy for coma due to meningitis. He performed the operation a year later, having

2. Pott, P.: Observations on the Nature and Consequences of Wounds and Contusions of the Head, Fractures of the Skull, Concussions of the Brain, etc., London, 1760.

3. Gross, S. W.: An Examination of the Causes, Diagnosis and Operative Treatment of Compression of the Brain as Met with in Army Practice, Am. J. M. Sc. **66**:57 and 63, 1873.

4. Robson, A. W. M.: Tapping and Draining the Ventricles in Certain Cases of Brain Disease, Brit. M. J. **2**:1292 (Dec. 6) 1890.

been antedated in the actual performance by von Bergmann [5] and Quincke,[6] who made use of it in 1888, in tuberculous meningitis and hydrocephalus, respectively. Mayo Robson was closely followed by a number of operators, such as Keen, Kocher [7] and McCosh, who applied the method in such conditions as meningitis, brain tumors and epilepsy.

The plan next suggested and executed for relief of persons with meningitis was to attack by drainage at an entirely different point, namely, the spinal subarachnoid space in the lumbar region. W. Essex Wynter [8] conceived and performed the first spinal drainage for the treatment of patients with meningitis in February, 1889. Nearly two years later, Quincke performed lumbar punctures according to a technic devised by himself, which has been accepted and universally practiced ever since.

To Ballance [9] probably belongs the credit for first attacking meningitis by the occipital route. According to his statement, made in 1897, he claimed to have performed the operation of draining the posterior subarachnoid cistern six years previously, in 1891: "The occipital bone was trephined close to the foramen magnum . . . Some cases had to be opened on both sides of the midline so as to prevent hernia of the cerebellum interfering with drainage."

Alfred Parkin,[10] in 1893, operated on a child who had been sick for a month with meningitis. At the time of the operation, there were Cheyne-Stokes' respiration, swelling of the optic disks and unconsciousness almost amounting to coma. Parkin opened the skull through the occipital bone, incised the dura and passed a curved probe along the under surface of the cerebellum, liberating a large quantity of cerebrospinal fluid, which relieved the symptoms of pressure. He then introduced a very fine capillary drainage tube. Here is the first definite description of an effort to cure persons with meningitis by continuous drainage of the cisterna magna.

Numerous attempts followed by various operators to secure benefit in meningitis by subarachnoid drainage by the occipital, temporal or

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5. Von Bergmann, E.: Die Chirurgische Behandlung von Hirnkrankheiten, Berlin, Hirschwald, 1889, p. 179.

6. Quincke, H.: Ueber Hydrocephalus, Verhandl. d. Kong. f. inn. Med. **10:** 321, 1891.

7. Kocher, T.: Hirnerschütterung, Hirndruck und Chirurgische Eingriffe bei Hirnkrankheiten, Spec. Path. u. Therap., 1901, vol. 9, part 3, section 2.

8. Wynter, W. E.: Four Cases of Tubercular Meningitis in which Paracentesis of the Theca Vertebralis was Performed for the Relief of Fluid Pressure, Lancet **1:**981 (May 2) 1891.

9. Ballance, C.: Case of Meningitis, Brit. M. J. **1:**1902, 1897.

10. Parkin, A.: The Relief of Intra-Cranial Pressure by the Withdrawal of Cerebrospinal Fluid from the Basal Subarachnoid Cavity, Lancet **2:**21, 1893.

lumbar, or by the combined craniolumbar, route. Macewen [11] deserves credit for pioneer planning and operating in this type of meningeal inflammation. He gave a summary of twelve cases of infective purulent leptomeningitis, in six of which operation was performed and the patients recovered. He looked on drainage of the meninges through "single or multiple laminectomies with irrigations as a possible hope if the pus is still fluid."

Hinsberg [12] reported seven cases of meningitis of otitic origin. Five of the patients were temporarily improved after drainage of the subarachnoid cavity. In the otologic literature there are numerous similar cases on record in which a craniotomy, in connection with the operation on the diseased ear, was performed to reach and drain a circumscribed or general purulent meningitis.

The use of continuous drainage of the spinal canal was reported by Horsley [13] in 1890, and was employed shortly afterward by several others. The two favorite sites for cerebrospinal drainage are the lumbar spinal canal and the cisterna magna. In 1912, Haynes [14] revived drainage of the cisterna magna, devising an operative procedure much like the one advocated by Murphy [15] in 1907. His three patients, who were operated on in the late stage of the disease, died without obtaining more than transitory benefit. In 1913, Day [16] faithfully tried Haynes' method on twelve patients, only one of whom survived. In 1913, Dench used the same operation on three patients without success.

Two cases of streptococcal origin have been reported by Rainey and Alford [17] (1923), who advocated continuous spinal drainage from the lumbar region. In 1924, Dandy [18] reported treating four patients with meningitis by continuous drainage of the cisterna magna. The infecting organism was staphylococcus or streptococcus. Three of the four patients survived.

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11. Macewen, W.: Pyogenic Infective Diseases of the Brain and Spinal Cord, New York, The Macmillan Company, 1893.

12. Hinsberg, V.: An Operative Treatment of Purulent Meningitis, Arch. Otol. **35**:484, 1906.

13. Horsley, V.: Surgery of the Central Nervous System, Brit. M. J. **2**:1286 (Dec. 6) 1890.

14. Haynes, I. S.: The Surgical Treatment of Meningitis—Its Scope and Accomplishment, Tr. Am. Laryng. Rhinol. & Otol. Soc., 1912, p. 186.

15. Murphy, J. B.: Neurological Surgery, Surg. Gynec. Obst. **4**:385 (April) 1907.

16. Day, E. B.: A Report of Otitic Meningitis Treated by Drainage of the Cisterna Magna, Tr. Am. Otol. Soc. **13**:180, 1913-1915.

17. Rainey, W. R., and Alford, L. B.: The Treatment of Septic Meningitis by Continuous Drainage, J. A. M. A. **81**:1516 (Nov. 3) 1923.

18. Dandy, W. E.: The Treatment of Staphylococcus and Streptococcus Meningitis by Continuous Drainage of the Cisterna Magna, Surg. Gynec. Obst. **39**:760 (Dec.) 1924.

Attempts have also been made to drain the lateral pockets of the cisterna magna and of the pontile cisterna by a dural defect in the mastoid (Eagleton). Drainage of the entire cerebrospinal system is possible under normal conditions, at least, from the spinal canal, the cisterna magna or any of the basal cisternae.

Under abnormal conditions of infection, the possibility of drainage of the entire cerebrospinal system will be dependent on the changes induced by the particular infection at hand. The reaction of the meninges as evidenced by the changes in the cerebrospinal fluid and in the meninges varies greatly with different organisms.

Subarachnoid Lavage.—These methods, which appear to be correct surgical principles, continue to be attractive in the effort to eventuate cure. Several variations of the basic principles have been tried, such as: (1) intermittent drainage by repeated lumbar punctures; (2) continuous drainage from the spinal canal, the cisterna magna, the pontile cisterna, the lateral ventricles and the parietal subarachnoid space; (3) irrigation of the subarchnoid space by bland solutions, antiseptics, specific serums and chemotherapeutic specifics. Horsley accepted the principle of drainage and in 1890 introduced irrigations of the spinal subarachnoid space. He irrigated the spinal canal from the lumbar region to the cisterna magna, with a solution of mercuric chloride. Murphy, in 1907, irrigated from the lumbar region to the cisterna magna; Barr, in 1910, from the sylvian region to the cisterna magna, and Day, in 1913, from the ventricles to the lumbar region, using saline solution, without results. Eagleton, in 1921, adopted a much more radical form of irrigation of the subarachnoid space with Ringer's solution. He made multiple openings over the cortex and irrigated in a retrograde direction into the cisterna magna. He successfully performed an irrigation of the subarachnoid spaces in a case of meningitis following fracture of the skull.

The use of antiseptic solutions for irrigation has been tried by many and doubtlessly causes injurious rather than beneficial effects. Prior to the revolutionization of the treatment of meningococcus meningitis by Flexner's serum, attempts were made to cure persons with the disease by injection or irrigation with antiseptic solutions.

Weed, Wegeforth, Ayer and Felton [19] of the American Army Neurosurgical Commission supplied impressive facts pertaining to chemical irrigation. It was shown that even physiologic sodium chloride solution used for irrigation of the spinal canal of cats with meningitis caused chemical irritation manifested by convulsions, marked tetany-like shak-

19. Weed, L. H.; Wegeforth, P.; Ayer, J. B., and Felton, L. D.: The Production of Meningitis by Release of Cerebrospinal Fluid, J. A. M. A. **72**:190 (Jan. 18) 1919.

ing of the body, and retraction of the head and neck; in a high percentage of cases, death quickly followed from respiratory paralysis.

Dandy and Blackfan [20] demonstrated that the meninges are extremely sensitive to chemicals and that only a perfectly neutral solution may be used. Dandy, in 1924, said: "The evidence is surely adequate to eliminate from consideration the treatment of purulent meningitis by the irrigation of the subarachnoid space by any of the antiseptics heretofore used."

When Dandy advocated continuous drainage of the cisterna magna, he limited the method to meningitis in which the infecting organisms are the staphylococcus and streptococcus, thinking that the pneumococcus infection, which quickly produces a thick tenacious fibrinous exudate, would not respond as do the infections in which the cerebrospinal fluid remains limpid. Therapy for the pneumococcus infections was suggested in 1926 by Kolmer [21] in an enthusiastic report of results obtained in the experimental infection of dogs. He felt that lavage of one or both lateral ventricles to the cisterna magna proved effective, and that it might be combined with the injection of antibody solution. He also advocated gentian violet for the streptococcus type of infection. An experimental study of pneumococcus meningitis was published by Stewart [22] in 1927, in which he supports the use of extensive lavage with an optochine serum mixture. He stated that the important factor in securing a cure is contact of all regions with the optochine serum mixture. While lateral ventricular punctures were not made in the dogs, he felt that it was fairly certain that sterilization would have been hastened and that recovery would have resulted in more instances. He concluded that the most difficult areas to reach with serum were the ventricles and the base of the brain in the region of the chiasm. In case these methods should ever be employed in treating disease in man, failure to sterilize by the quadruple puncture route should suggest ventricular punctures and puncture through to the base.

THE ANATOMIC RELATION OF THE SUBARACHNOID SPACES

Since the invasion of the subarachnoid spaces by proliferating organisms and toxins and the various methods of removal of infection from these spaces are being considered, the anatomy and embryology of the region should be reviewed.

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20. Dandy, W. E., and Blackfan, K. D.: An Experimental and Clinical Study of Internal Hydrocephalus, J. A. M. A. **61**:2216 (Dec. 20) 1913; Internal Hydrocephalus, an Experimental, Clinical and Pathological Study, Am. J. Dis. Child. **8**:406 (Dec.) 1914.

21. Kolmer, J. A.: The Chemotherapy and Serum Therapy of Pneumococcus and Streptococcus Meningitis, Arch. Otolaryng. **3**:481 (June) 1926.

22. Stewart, Fred W.: Local Specific Therapy of Experimental Pneumococcal Meningitis, J. Exper. Med. **46**:409 (Sept.) 1927.

The cerebrospinal fluid circulates in a closed system of spaces. The interior or ventricular part of the system is concerned with the formation of the cerebrospinal fluid; the exterior or subarachnoid part, with the absorption of the fluid. Under normal conditions the entire system of cerebrospinal spaces, both ventricular and subarachnoid, is in free communication.

Communications between the ventricular and subarachnoid divisions of this system are through three openings in the fourth ventricle—the paired foramina of Luschka and the mesial foramen of Magendie.

The subarachnoid part of the cerebrospinal system consists of a single large lake, without restricting anatomic subdivisions underlying the brain stem, the interpeduncular and interchiasmal regions of the brain, and surrounds the spinal cord and the posterior aspect of the cerebellum. From this lake many branches radiate over the cerebral and cerebellar surfaces, forming a network of intercommunicating channels and pools. Over the cerebrum, these spaces follow the irregularly distributed interconvolutional sulci.

Development and Formation of the Subarachnoid Spaces.—"Galen, father of anatomy, and later Vesalius, in the sixteenth century, described a thin membrane surrounding the brain underneath the dura, but neither of them recognized the arachnoid membrane or the subarachnoid space. In fact, the arachnoid was not established as a membrane separate from the pia mater until the middle of the seventeenth century. It was given its name by Blaes (Blasius), an anatomist of Amsterdam (1626-1682), arachnoid being derived from the Greek word ἀράχνη, meaning a spider's web. Soon afterward Varioli, an Italian investigator, showed that this membrane existed separately even under the base of the brain. . . . In Germany, Vieussens, in 1690, described two separate thin membranes of the spinal cord, and in 1697, an anatomist in Holland, named Ruysch, confirmed the extent of the arachnoid over the cortex and base of the brain."

In 1802, Bichat [23] advocated the theory that the arachnoid was a double serous membrane, identical with serous membranes elsewhere in the body, forming a closed sac, the "arachnoid cavity," in which the cerebrospinal fluid was formed. In 1839, Knox [24] pointed out the large arachnoid spaces about the base which are now known as basal cisternae. He injected air, ink and colored water into these basal spaces; finding that they did not pass into the ventricles, he advanced the theory that there was no connection between this space and the ventricles.

23. Bichat: Traite des membranes, Paris, 1802, trans. by Coffin; A Treatise of the Membrane in General and Different Membranes in Particular, Boston, 1813.

24. Knox, R.: Commentary on "Anatomical Remarks on the Membranous Coverings of the Brain and Spinal Marrow" by F. Arnold, Lancet **1**:112, 1839-1840.

It was left to Magendie,[25] in 1842, to prove that the cerebrospinal fluid was contained in the subarachnoid space. He furthermore showed that the fluid circulated and had a definite positive pressure. He described the extent of the subarachnoid space over the cortex and found that it continued around the gasserian ganglion, out along the acoustic nerve and along the optic nerve in the orbit. He called the large subarachnoid spaces at the base of the brain "confluents" and mentioned four of them; the cerebellomedullaris, a second located under the pons and between the cerebral peduncles, a third lying behind, above and on both sides of the pineal gland and a fourth in the region of the optic chiasm. His conclusion was that all these various subarachnoid spaces were in open connection with each other.

Many later authors believed that there was fluid in the subdural space also, although in much smaller quantity. They did not recognize, however, as Magendie did, that the different subarachnoid spaces were in free communication with each other. They were confused by the idea of Bichat, and it was not until 1870 that Grey's "Anatomy" gave up the idea of a double arachnoid membrane.

In 1875, Key and Retzius'[26] monumental work appeared, which described graphically and illustrated clearly the extent of the subarachnoid space. Coagulating masses colored with Berlin blue were injected into human specimens, following which the cranium was either cut away or the whole head was frozen or sectioned. This procedure demonstrated many more or less indefinite points concerning the extent of the subarachnoid spaces. These authors described the subarachnoid cisternae of the brain in more detail than Magendie had done, naming seven of them.

After the study made by Key and Retzius little work was done on the subarachnoid spaces till 1924, when Locke and Naffziger[27] described casts made of the subarachnoid spaces by injecting celloidin and camphor dissolved in acetone. The large subarachnoid space at the base had been described as three cisternae, but because these parts were so completely continuous these authors preferred to call the entire space the cisterna basalis and designated its different respective portions as pars pontis, pars interpeduncularis and pars chiasmatis. The latter is the portion of the cisterna basalis located farthest forward. It advances for a short distance anteriorly beneath the frontal lobes in front of the

25. Magendie, F.: Recherches physiologiques et cliniques sur le liquide cephalo-rachidien ou cerebro-spinal, Paris, Mequignon-Marvis fils, 1842.

26. Key and Retzius: Studien in der Anatomie des Nervensystems und des Bindegewebes, first half, Stockholm, Samson & Wallin, 1875-1876.

27. Locke, C. F., Jr., and Naffziger, H. C.: Cerebral Subarachnoid System, Arch. Neurol. & Psychiat. **12**:411 (Oct.) 1924.

chiasm, and posteriorly it fills in the space between the diverging posterior limbs of the chiasm. The pars chiasmatis also extends about the chiasm and the infundibulum, as well as continuing along the optic nerves toward the globes. Although the narrowest, it is the deepest portion of the cisterna basalis.

Posterior to the pars chiasmatis lies the pars interpeduncularis, which extends laterally as far as the cerebral peduncles and posteriorly as far as the anterior border of the pons. It is less deep than the pars chiasmatis, and from its collar-like fluid spaces reach out along the oculomotor nerves.

The pars pontis lies posterior to the pars interpeduncularis, and here the basal cistern water-bed spreads laterally, forming on each side a large triangular space with its base at the midline. The apexes of these triangular spaces extend laterally over the anterior aspect of the pons to the cerebellopontile angle (lateral cistern). Here the seventh and eighth pairs and the ninth and tenth pairs of cranial nerves are surrounded by an extension of the pars pontis, as are the gasserian ganglions. Posteriorly, the pars pontis is very much wider than the other portions of the cisterna basalis, yet it is comparatively shallow, being about one-fifth the depth of the pars chiasmatis.

The cisterna magna cerebellomedullaris is the second unit of the main cerebrospinal fluid pathway. It lies for the most part in the angle made by the junction of the cerebellum and medulla, on the dorsal aspect of the brain stem. Superiorly, it is bounded by the cerebellum and the fourth ventricle and inferiorly by the medulla. Laterally, it extends out on the inferoposterior surface of the cerebellum and over the lateral borders of the medulla to join the cisterna basalis.

From the main cerebrospinal fluid pathway composed of the midline cisternae, the smaller pathways or subarachnoid channels take their origin and extend upward over the cortex.

Weed,[28] who made a thorough study of the formation of the subarachnoid spaces, said that the central nervous system is surrounded in the stages before the outpouring of cerebrospinal fluid from the cerebral ventricles by the undifferentiated perimedullary mesenchyme. This tissue is of a loose character, forming a syncytial network of rather small but fragile mesh. This fine-meshed mesenchyme is the tissue into which the embryonic cerebrospinal fluid passes when the elaboration of the fluid exceeds the intraventricular capacity. Shortly after the initial transit of the fluid into the extraventricular spaces, the process of differentiation of the tissue to form the final subarachnoid

28. Weed, L. H.: The Formation of the Cranial Subarachnoid Spaces, Anat. Record, 1916, vol. 10; The Cells of the Arachnoid, Bull. Johns Hopkins Hosp. **31**:343 (Oct.) 1920.

spaces occurs. This undifferentiated mesenchyme, through the advance of the ventricular fluid, develops into a far looser tissue. The process is apparently a metamorphosis of certain strands of the mesenchyme into the heavier and stronger trabeculae of the subarachnoid spaces.

> This general plan of the formation of the subarachnoid channels attains its maximum in the transformation of the primitive mesenchymal meshes into the larger cisternae of the adult cerebrospinal fluid. The process is best illustrated in the posterior cerebellobulbar angle where the cisterna cerebellomedullaris is formed. . . . The outer portion of the cisterna is formed by a continuous membrane, which, after somewhat further differentiation, will become the outer continuous layer of the arachnoidea.

In addition to this formation of the subarachnoid spaces in the adult through the enlargement of the embryonic mesenchymal spaces, the perimedullary mesenchyme undergoes in the same localities condensations that result ultimately in the formation of the arachnoid membrane and the trabeculae dividing up the cavum subarachnoidale. Some of the cell bodies of the disrupted mesenchymal elements adhere to the persisting strands. Gradually, with the increasing growth, these cells seemingly become arranged in definite columns covering the persisting arachnoidal trabeculae. This differentiation begins first in the basilar portion of the cranium and spreads upward, in a way similar to the course of development of the cranium and of the enlargement of the pericerebral spaces.

Such a general process as the one outlined accounts for the formation of the arachnoidal trabeculae and the subarachnoid spaces.

Histology.—The outer of the two more delicate investing membranes of the central nervous system—the arachnoid—is customarily described as a thin, continuous membrane of a glistening external surface beneath the dura, bridging the cerebral sulci and containing beneath it the cerebrospinal fluid. This structure should be arbitrarily divided into two parts—the arachnoid membrane (the outer continuous cell layer investing the whole central nervous system) and the arachnoid trabeculae (the cell columns which stretch from the inner surface of the arachnoid to the pia mater). The arachnoid becomes, then, a cellular structure with a delicate supporting reticulum covered on both sides by characteristic cells. From the inner side of this membrane project delicate trabeculae, on which are continued the cells forming the inner lining of the arachnoid membrane. The larger trabeculae possess a core of a few connective tissue fibrils united on the outer side with the fibrous framework of the arachnoid membrane and on the inner side with the subpial tissues; the smaller trabeculae seem to be composed merely of the cytoplasmic processes of the lining cells. The lining cells, reflected from the inner surface of the arachnoid membrane and continued on the trabeculae, become the cells covering the pia mater.

Between these two membranes is the subarachnoid space; it is merely an intraleptomeningeal fluid channel. The passages through the space are interrupted by the arachnoid trabeculae, so that the circulating cerebrospinal fluid must traverse a devious, tortuous but continuous channel.

THE OTOLOGIST'S INTEREST IN THE SUBARACHNOID SPACES

Locke and Naffziger, after their study of the subarachnoid spaces and the routes of distribution of the cerebrospinal fluid, suggested that the spread of meningeal infections would follow or be directed by the anatomic lines of the basal cisternae. This would hold obvious possibilities for following the intracranial progress of a complicating infection. One can be certain of the usual pathways by which infection from the ear enters the cranium, and with a definite knowledge of how the infection would be directed after its entrance into the subarachnoid space, one could follow the condition and perform drainage in a more successful manner. At first infection would probably be limited to the cistern where it enters, so drainage of this cistern would be necessary. It would be essential to know only the pathways by which to drain the different cisternae. With this thought in mind, an effort was made to determine whether the infection would follow any definite route.

Injections were attempted along the different pathways of infection to see whether there was any anatomic direction of the injected fluid. The method of Key and Retzius was followed in using a solidifying substance for injection. Gelatin colored with methylene blue was injected through the dura and arachnoid with slight pressure. This material localized and showed a definite demarcation in the pars pontis of the cisterna basalis (fig. 1). However, this experiment was not free from the suspicion that the localization was not due to anatomic limitation but to the intrinsic solidifying property of the gelatin. A second experiment was made by injecting an aqueous solution of methylene blue into the subarachnoid space through the tegmen antri. The fluid immediately spread over the cerebral cortex without any apparent limitation (fig. 2). There did not seem to be evidence of subarachnoid channels directing the spread of meningeal infection, but rather an open, freely communicating space. It is true that there are trabeculae traversing the space from the arachnoidea to the pia, yet these in no sense form a barrier or a wall making a definite limitation of extent, but rather by their variations in length or number they may limit the depth of the subarachnoid space.

It must be recognized, however, that there are tissue reactions which tend to limit the progress of infection, and this barrier of inflammatory reaction may appear anywhere and does not follow anatomic lines. Eagleton said that in the primary stage of suppurative meningitis, the result of the extension of a suppurative process from an adjacent focus (such as the ear), the infection is limited to an area of the system. Following this primary stage and frequently for a considerable period,

the infective process is chiefly confined to the basal cisterna. In necropsies performed on patients who have died from acute suppurative meningitis, the collection of the fibrinopurulent exudate in the cisterna basalis is striking to see. The proof of the existence of this large cisterna and evidence of the free communication of its parts suggest the desirability of its drainage and lavage to prevent the formation of the plastic exudate in such a vital position.

It is the consensus of opinion that suppurative meningitis should be attacked surgically, and, in addition to removal of the primary focus

Fig. 1.—Localization of blue gelatin in cisterna basalis after injection into subarachnoid space from jugular bulb.

of infection, drainage and possibly lavage of the subarachnoid space offer the greatest prospect of benefit. Kolmer said:

> Certainly it is one of the outstanding and clearest conclusions of our experimental study that drainage alone, or drainage with lavage, constitutes the most important phase of treatment, and it is earnestly hoped that there will be a wider and clearer realization of the fact that pneumococcus and streptococcus meningitis are surgical problems demanding the institution of much better drainage and treatment than afforded by merely one or two spinal punctures a day with the intraspinal injection of an antiserum.

He believed that the use of lavage alone is promising in the treatment of persons with septic meningitis, provided treatment is instituted sufficiently early in the disease. It is essential to make the diagnosis as early as possible and to begin treatment without delay.

If a purulent fluid is recovered when a diagnostic puncture of the arachnoidea is made, indicating the presence of a widespread leptomeningitis, the case should be regarded at once as one requiring operative intervention. Drainage of the local focus of infection if present or discoverable, the performance of trephining and puncture of a ventri-

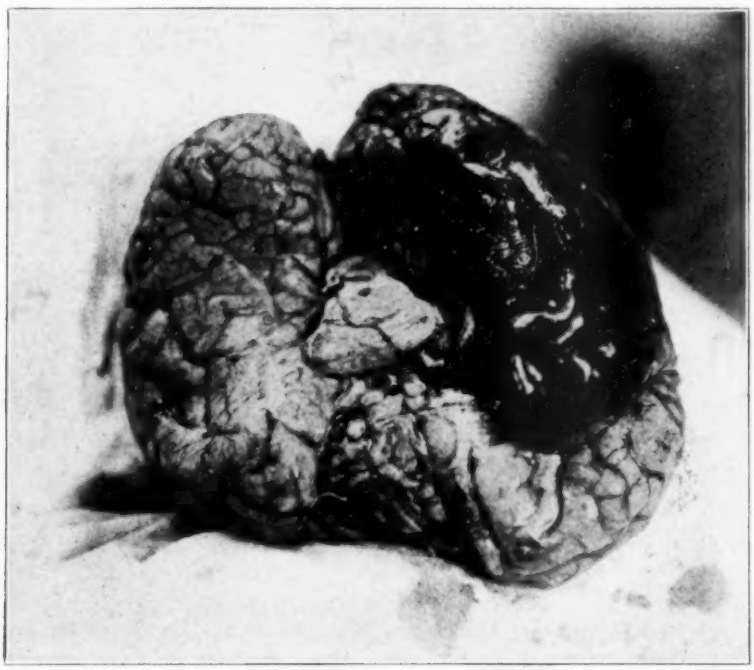


Fig. 2.—Base of brain showing diffuse spread of watery solution of methylene blue in subarachnoid space.

cle, together with puncture of the cisterna magna and lavage from the ventricles to the cistern, are indicated. Kolmer was convinced that septic meningitis kills from the cistern upward rather than by spinal meningitis.

Stewart concluded that great benefit might be gained in irrigation in experimental pneumococcic meningitis in dogs if the irrigation could reach all parts of the subarachnoid system more thoroughly. The important factor in obtaining cures is to bring all regions of the meninges in frequent contact with the therapeutic agent.

One cannot but feel that the exceptional results from the experimental procedures are due to the operators having had a definite knowledge of the disease at hand and also of the exact time of onset. Early combat of the infecting organism, before twenty-four hours have elapsed, is essential.

The inflammatory reaction of the meninges with the production of a fibrinopurulent exudate in the basal cisterna, as is the typical observation at necropsy, is in itself a great factor in causing the universally fatal results of the disease. If the cerebrospinal fluid is to function as a protective agency, its normal circulation must be preserved. From the physiologic point of view, the cerebrospinal fluid must always be considered as a circulating fluid, the function of which is lost when its circulation is interfered with. The very processes which are protective in other parts of the body predicate a fatal termination. The adhesions and the formation of a fibrinous exudate filling the basal cisterna interfere with any elimination of toxins that the circulating cerebrospinal fluid might afford, give comfort to the proliferating organisms and contribute to the increasing intracranial pressure. The only prospect of cure is drainage, with the possible addition of lavage. As has been mentioned, this has long been favored and attempted both experimentally and as a curative measure for the actual disease without making any remarkable alteration in the mortality statistics. In all the writings on the subject the thought seems to enter that if the principle could be made a little more extensive it might be more successful. The result might also be more favorable, as Stewart intimated, if drainage and lavage could be performed on the base of the brain.

It is in the basal cisterna that necropsy shows the confluence of the greatest amount of fibrinopurulent exudate. This is adjacent to the vital centers and the point from which compression of the brain starts. An opening at this point forming an exit for the infected material washed from the frontal punctures, ventricular puncture or occipitoatloid puncture, should assist in making the surgical treatment in suppurative meningitis more successful.

At the suggestion of Bissett,[29] an effort was made to open the cisterna basalis for drainage through the basilar process of the occipital bone from the nasopharynx.

The soft palate was split just to the side of the uvula, and the soft parts in the midline of the posterosuperior wall of the nasopharynx separated, clearing the inferior surface of the basilar process of the occipital bone. An opening in the bone 1.5 cm. in diameter was made with a gage 1 cm. posterior to the free border of the nasal septum. The dura over the pons was revealed. Opening the dura and arachnoid leads into the pars pontis of the cisterna basalis and allows

29. Bissett, John V.: Personal communication to the author.

a point of exit for irrigating solution from the occipito-atloid puncture adjacent to the earliest pathologic lesions (fig. 3). An objection to such drainage that may be mentioned is the danger of a superimposed infection. This objection deserves to be entertained, but one is dealing with desperate cases in which the slight risk incident to manipulation is far outweighed by the added chances of recovery. It must be said, moreover, that in the presence of an infection, additional infection is less likely to occur or to assume serious proportions than with normal meninges, because barriers against it have already been raised in the presence of the preexisting infection.

Fig. 3.—Base of skull with instrument penetrating pars pontis of cisterna basalis from nasopharynx.

As regards irrigation of the arachnoid space between two openings, there is much to be said for its use. It would not seem necessary, however, if free continuous drainage can be maintained, for it is well known that when the subarachnoid cavity has an external opening the rate of formation of spinal fluid probably increases to several hundred cubic centimeters daily, and the fluid itself thus forms an ideally constituted and correctly flowing solution for irrigation.

As has already been pointed out, the effectiveness of subarachnoid irrigation is dependent on the promptness with which it is undertaken after the onset of the infection. The earliest possible diagnosis, based on the changes in the spinal fluid, should be made. If the fluid is obtained by lumbar puncture alone, valuable time is lost because of the distance from the point of entry of the infection. Examination of the cerebrospinal fluid taken by cisternal puncture would give a more accurate picture of its changes near the active pathologic process and the vital centers. The cisternal puncture has been too long considered a diagnostic procedure of last resort. The technic of cisternal puncture has been amply described by Ayer [30] in this country, and by Eskuchen [31] abroad.

Significant pathologic changes are detected earliest by examination of the fluid obtained by puncture of the cisterna. The important fact in diagnosis is the presence or absence of micro-organisms. Direct smear and culture should be made, as well as an estimation of the sugar content. A complete examination of the cerebrospinal fluid should be made, but the points enumerated are the most significant as they and they alone enable one to differentiate between an acute suppurative meningitis and a meningitis sympathica. The latter will give the whole picture of septic meningitis, except the presence or evidence of organisms, which tell the physician not to stop after eliminating the primary focus but to follow this by subarachnoid drainage and irrigation.

SUMMARY

The subarachnoid cavity as the place of proliferation of the invading organisms should be regarded as an abscess cavity. It is a freely communicating space and is amenable to the time honored principles of drainage and irrigation if these remedies are attempted sufficiently early. These continue to be the most attractive possibilities, and investigators suggest that greater success may follow if they are applied more extensively. An opening into the pars pontis of the cisterna basalis through the basilar process of the occipital bone is offered as a suggestion of another point from which to perform drainage or lavage. The earlier evidence of changes in the cerebrospinal fluid in the cisterna magna could be detected by more frequent puncture of this cavity.

It should be emphasized that drainage alone or drainage and lavage cannot cure persons with meningitis. In the final analysis, the body

30. Ayer, J. B.: Puncture of the Cisterna Magna, J. A. M. A. **81**:358 (Aug. 4) 1923; Puncture of the Cisterna Magna, Arch. Neurol. & Psychiat. **4**:529 (Nov.) 1920.

31. Eskuchen, K.: Die Punktion der Cisterna Cerebellomedullaris, Klin. Wchnschr. **2**:1830 (Oct. 1) 1923.

must be able to combat the infection, and if this is impossible, drainage will be unavailing. Drainage can help the natural protective agencies fight the disease only by removing the intracranial pressure and by eliminating much of the infection. It is not to be expected that any procedure will do more than reduce the high mortality rate which exists at the present time.

225 Ballantine Parkway.

Clinical Notes

RIGHT HEMIPLEGIA, APHASIA AND APHONIA FOLLOWING GUNSHOT WOUND OF THE NECK: REPORT OF A CASE*

JOHN L. GARVEY, M.D., ANN ARBOR, MICH.

Cerebral accident secondary to gunshot wounds in the neck are sufficiently rare in civil practice to warrant reporting a case. In military practice, cases are relatively less infrequent. George Makins,[1] temporarily surgeon general and consulting surgeon to the British forces, reported fourteen cases and reviewed them critically. Colledge and Dunn[2] reported four cases of hemiplegia caused by embolism in the carotid artery following gunshot wound which occurred in military practice; these reports included the autopsy observations.

REPORT OF A CASE

E. F., aged 24, a housewife, was examined eight weeks following a gunshot wound of the neck. She complained of difficulty with speech and in writing the names of some objects, even with the left hand. The injury occurred when an officer shot the patient from a distance of about 200 feet. She immediately became unconscious and was driven to a hospital, a distance of about a mile. It was said that she bled profusely from a wound 1½ inches (3.7 cm.) to the left of the spine, at the level of the lower border of the sixth cervical spinous process. She remained unconscious for about forty-eight hours. Surgical intervention was not employed. After the patient regained consciousness, it was noted that she was unable to move the right arm or leg and could not talk. There was also an incomplete paralysis of the right side of the face. From then until this examination, the symptoms gradually improved. When examined eight weeks after the injury, she was well nourished and seemed to be fully conscious of her surroundings. She understood everything that was said to her. There was a partial motor aphasia and agraphia. The partial aphasia was represented by whispered tones. The right pupil seemed slightly larger than the left; they both reacted to light and in accommodation. The extra-ocular movements were normal, and nystagmus was not noted. There was a residual cerebral paralysis of the right side of the face, but no paralysis of the tongue. She complained that the left side of the face perspired more freely than the right. There was a paralysis of the left vocal cord, together with some twisting of the larynx to the left side. Evidence of perforation of the larynx or hypopharynx was not found. The results of the examination of the fundus were negative, and there was no deformity of the visual fields. There was incomplete agraphia, for the patient could write

* Submitted for publication, May 23, 1928.

* From the Department of Neurology, University of Michigan Medical School.

1. Makins, G. H.: Cerebral Embolism Consequent on the Reception of Gunshot Injury to the Carotid Arteries, Lancet **2**:543 (Sept. 23) 1916.

2. Colledge, L., and Dunn, John Shaw: Four Cases of Hemiplegia Caused by Embolism Following Gunshot Wounds of the Carotid Arteries, Lancet **1**:57 (Jan. 13) 1917.

with the left hand the names of some, but not of all, of the objects about the room. The thyroid gland was not palpable, and tumor masses were not noted in the neck. The carotid artery could not be palpated on the left side of the neck. There were two scars, the result of the gunshot. The posterior scar was located approximately 1½ inches from the midline on the left at the level of the lower border of the spinous process of the sixth vertebra. It was well healed and about half an inch (1.27 cm.) in diameter. The second scar was just to the right of the thyroid cartilage, and about the size of a small pea. There was a partial hemiplegia on the right side, with increased tendon reflexes. Babinski's sign was present on the right side, and there was also an ankle clonus on this side. Roentgen studies of the cervical and upper thoracic spine did not show any evidence of injury.

COMMENT

There does not seem to be any doubt that the aphonia, aphasia and right hemiplegia are the result of the gunshot wound. Areas of cerebral softening are not uncommon following ligation of the common carotid or internal carotid artery for therapeutic reasons, when the collateral circulation through the circle of Willis is inadequate.

Perforating wounds of the arteries are usually assumed to be present when one of the following conditions exists: (1) a systolic arterial bruit; (2) an arterial venous murmur; (3) a pulsating swelling over the vessel and, (4) secondary hemorrhage demanding surgical intervention.

In the foregoing case, these signs were absent. A nonpenetrating injury to the artery is assumed when the aforementioned signs are absent and when the vessel distal to the injury does not pulsate. In five of Makin's cases, there was evidence of injury to the cervical sympathetic chain of nerves, and in these five cases there was sufficient evidence to show that the wounds were of the nonpenetrating type. In the foregoing case, the sympathetic chain apparently was involved somewhat, as shown by the disturbance in the secretion of the sweat glands on the left side of the face. Additional evidence of this conclusion was the coexistence of signs of injury to the left laryngeal nerve, a closely contiguous structure. Injury to this nerve has not been noted previously in this regard.

Makins, in discussing the question as to whether the cerebral involvement was due to anemia caused by thrombosis of the internal carotid artery, or whether it was due to an embolus resulting from a thrombosis, contended that it was probably the latter. He based this contention on the fact that in most cases of therapeutic ligation of the carotid artery, the hemiplegia usually occurs immediately, and in more than one instance is followed by a fatal issue in the course of from twenty-four to thirty-six hours. In his series of fourteen cases, only one case ended fatally, and in a number of cases the symptoms of cerebral involvement were tardy in appearance. In one case, hemiplegia occurred one hour after injury; in another, twelve hours after injury, when the patient had walked a mile. In a fourth case, the paralysis came on twenty-four hours after the ligation of the left common carotid artery; in two cases, it supervened three days after injury to the neck. In another case, the embolus was detached from an aneurysmal sac four days after the right common carotid artery had been occluded by proximal ligation. The theory that the cerebral accident is caused by embolism of the carotid artery rather than by thrombosis with cerebral anemia is well supported by the cases of Colledge and Dunn. In their four cases that ended fatally, necropsy showed that the cerebral disturbances were caused by occlusion of the middle cerebral artery or its branches. However, in their four cases, there was considerable damage to the large cervical arteries.

SUMMARY

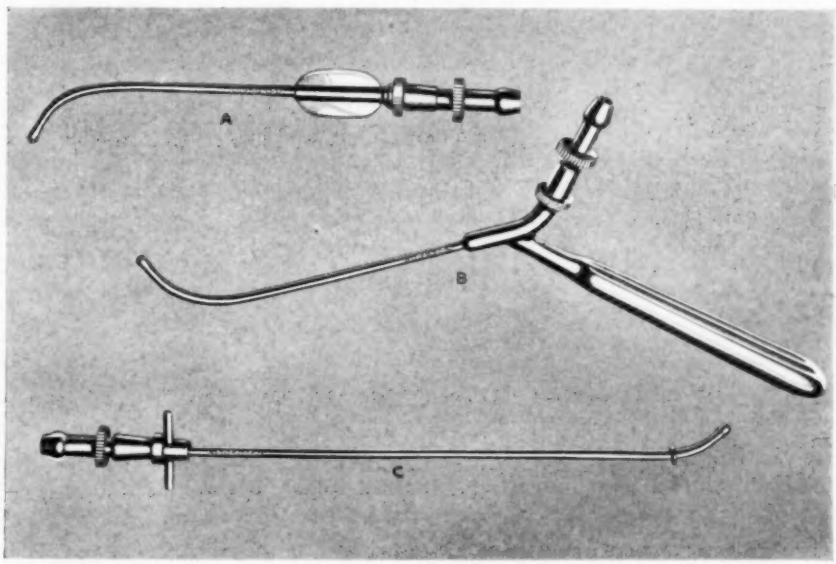
A case of extensive cerebral softening with injury to the left laryngeal nerve and sympathetic cervical chain due to a gunshot wound of the left side of the neck, causing a nonperforating injury to the carotid vessel with subsequent thrombosis and cerebral embolism, is reported. The coexistence of involvement of the laryngeal nerve as evidence of involvement of contiguous structures in association with a nonpenetrating injury of the carotid vessels causing thrombosis and cerebral embolism has not been noted previously.

IRRIGATION AND SUCTION CANNULAS, NEW AND MODIFIED, FOR THE FRONTAL, MAXILLARY AND SPHENOIDAL SINUSES*

JOSEPH W. MILLER, M.D., NEW YORK

MAXILLARY SINUS CANNULA

The maxillary sinus cannula is used for irrigation and suction of the antrum of Highmore, and is curved to a desired angle to slip easily into the antrums.



The tip is bulbous, so that injury could not occur to the mucous membrane; it is, in addition, fenestrated on the sides. This cannula has been modified from the von Eicken cannula, so that it can readily be attached to a Sorensen Sinus Cleanser or a standard slip fitting. By means of a flat metal guide, the direction of the cannula is easily determined.

FRONTAL SINUS CANNULA

The frontal sinus cannula is fashioned according to the old Guetig's model and curved so as to glide easily into the frontal sinus. The tip also is bulbous and

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* Submitted for publication, Sept. 20, 1928.

fenestrated on the sides. This cannula, in order to give it better support and steadiness, is constructed with a special handle, at an angle of about 135 degrees, which acts as a sort of a fulcrum to the support of the cannula. This instrument also can be attached directly to the Sorensen Sinus Cleanser or else attached to a standard slip fitting for irrigation purposes.

SPHENOID SINUS CANNULA

The sphenoid sinus cannula is 15 cm. from the shoulder to the guard and has the same advantages as the other two cannulas. It is made fool proof, in addition, by a special guard attached to the cannula just proximal to its curve.

305 East 17th Street.

FRONTAL SINUS RASP*

HARRY A. SCHATZ, M.D., PHILADELPHIA

The illustration shows a modification in the frontal sinus rasp which has been produced at my request.

Modification of frontal sinus rasp. L and R indicate left and right, the smooth face of the cross-section depicted being toward the respective orbit.

Its aim is to present a smooth edge rather than a serrated or cutting one against the thin wall of the orbit. In my teaching of cadaveric nasal surgery I have found that injury to the lacrimal bone occurs frequently.

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* Submitted for publication, Nov. 2, 1928.

Progress in Otolaryngology

A Summary of the Bibliographic Material Available in the Field of Otolaryngology

THE FUNCTIONAL EXAMINATION OF HEARING

DEAF-MUTISM AND THE EDUCATION OF THE DEAF *

ROBERT SONNENSCHEIN, M.D.
CHICAGO

During the past year many articles dealing with the functional testing of hearing and allied subjects have appeared. It was gratifying to be able to state in the reviews that appeared in January, 1927 and 1928, that American otologists are contributing a large number of excellent papers on this subject, so that there no longer seems to be the preponderance of European, and especially of German and Austrian, work on this subject that there was until a few years ago. The most encouraging fact, however, is that European authorities are beginning to read and take cognizance of the excellent American literature, of which they seemed entirely ignorant until recently. In several of the papers which I am reviewing in this issue, American work on functional testing of hearing, especially that done with audiometers, is receiving considerable attention. This is notably so in the case of the paper by Ruf and the one by Kahler and Ruf. Judging from the literature, European audiometers have been rather imperfect until recently, but now their makers are imitating or at least emulating the high class audiometers which have been perfected in this country.

Froeschels [1] has given further data regarding the symptom that he previously described in an article which I reviewed a year ago. As was noted at that time, the tones of the Urbantschitsch harmonica are conducted directly into the ear by means of a hearing tube, and the jerklike movements of the eye are observed. These movements resemble in many ways those noted with a positive fistula test. Twenty-four of twenty-nine children in the Deaf Mute School showed this sign. As a contrast,

* Submitted for publication, Nov. 30, 1928.

* This review includes articles published from November, 1927, to October, 1928. Some of the foreign journals do not arrive in time for the summary of the current year and so are reviewed during the following year.

1. Froeschels, Emil: Eye Muscle Reflex in Deaf Mutes, Due to Auditory Stimulus: Second Communication, Monatschr. f. Ohrenh. **61**:776, 1927.

only one of twelve infants with normal hearing aged from 1 week to 11 months, together with one hundred and fifty school children and twenty adults, showed a positive reaction in the right ear in which there was an impairment in the hearing due to involvement of the inner ear. The author feels that his clinical observations correspond a good deal with the experimental work of Tullio. The latter demonstrated that all movements of the eye, head and extremities which may be caused by mechanical stimulation of the semicircular canal may also be produced by auditory stimuli. Froeschels therefore expressed the theory (as he did in his previous article) that the "observed fatigue of the reflex perhaps permits the conclusion that at some time in the human race fixation movements of the eyes and the head of a reflex character followed uniformly auditory stimulation, and that the persistence of such reflexes in deaf mutes may be traced in part to the rarity of the perception of auditory stimuli and partly point to atavism."

Heermann [2] called attention to the well known fact that persons who suddenly become deaf naturally lose the auditory control of speech intensity before they have learned, by means of the laryngeal and respiratory musculature, to control properly the loudness of the voice. In the endeavor to hear their own voices, they always begin to scream. This phenomenon is, as is known, the basis for the Lombard reading test for the discovery of simulated deafness.

If a patient is instructed to read and a noise apparatus is placed in the normal ear, if he is actually deaf in the opposite ear he will at once raise his voice; he will again lower it when the noise is removed. If there is simulation and the apparatus is placed in the ears, he will likewise raise his voice; whereas if he is actually deaf in both ears, the loudness of the voice will not be influenced.

The author claims excellent results by the use of this method in functional disturbances of speech such as hysterical aphonia. The noises are produced in both ears, while the laryngologist examines the larynx with the mirror and instructs the patient to phonate; at the same time he conveys by his own facial expression the idea that he cannot understand the efforts of the patient, so that the latter is induced to speak louder and louder in the effort to make the physician understand. If difficulties arise, the patient can often be stimulated to speak by the introduction of a cotton applicator into the larynx. The author has had considerable success with such a maneuver not only in this class of cases, but also in patients during the period of mutation.

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2. Heermann, H.: The Treatment of Functional Speech Disturbances with Bilateral Artificial Deafening with Noise, Beitr. z. Anat. Physiol., Path. u. Therap. d. Ohres. **27**:60, 1928.

AUDITORY FATIGUE

Krukover [3] called attention to the work of Professor Komandantoff who emphasized the relationship of hearing fatigue to the impairment of the inner ear, and pointed out the practical value of the fatigue symptom. Although this article was published in 1926, its appearance in Russian prevented my seeing the translation until recently, and therefore it is included in the present review even though not covered by the period from Nov. 1, 1927, to Nov. 1, 1928.

Physiologic fatigue may be based on pathologic conditions either in the ear or in the general system, which may be considerably changed by stimulation of exogenous or endogenous origin. The author examined a large number of persons in various occupations and tabulated the results. These showed that persons who were exposed to chronic intoxications (as in cigaret factories, tanneries and similar places) showed greater fatigue than those employed in ordinary noisy work. But much greater fatigue is noted in those subjects who have functional disturbances such as neurasthenia and hysteria. He concluded that the degree of fatigue of the organ of hearing indicates the degree of its function, and that the excessive fatigue of the ear in patients in whom a definite cause cannot be found points to a general nervous state.

The conception that perception for tones of the scale takes place in different parts of the cochlea and may be impaired in part or throughout the entire scale makes it desirable to test separately the different parts of the tone scale, and to measure the intensity of the stimulation necessary to produce the sensation of hearing in those different parts.

AUDIOMETERS AND AIDS TO HEARING

It is important also to test each ear separately.[4] Bezold and Edelmann were the first to devise a means of testing the hearing for each tone in the entire range of hearing by means of tuning forks for the lower tones and a series of whistles for the upper tones. The two main defects in this method are the inability to measure accurately the intensity of the stimulation required for the perception in the different parts of the tone range and the difficulty of testing each ear separately.

In diseases of the ear affecting hearing, there may be diminution of hearing for the entire scale; often for one end or the other, or at times in the middle of the tone range; "but never do actual gaps or complete defects in the midst of the tone scale develop." The writers stated that

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3. Krukover, L.: Hearing Fatigue, Vestnik rino-laringo-otiatril., 1926, no. 4, p. 44.

4. Shambaugh, George E., and Holderman, Jacob W.: The Audiometer as a Device for Determining Quantitatively the Hearing Function in Each Ear Separately, Ann. Otol. Rhin. & Laryng. **37**:290 (March) 1928.

the use of the noise apparatus of Bárány is a delusion. It is not necessary to exclude one ear to determine a substantial remnant of hearing in the other. Furthermore, in those cases in which the reduction of hearing in one ear is marked, the use of the noise apparatus in the normal ear will drown out any remnant of hearing which may still be present in the affected ear.

The audiometer has been regarded by some as offering a satisfactory means for testing each ear separately. Investigations in the physics of the ear piece have been made and show that practically all the hearing is by air conduction when the ear piece is held in place. Persons with increased or decreased bone conduction, using the telephone with the receiver held close to the head, however, hear better or worse, respectively, an "evidence that bone conduction plays an important part in hearing over the phone." From this observation, one should expect bone conduction to play some part also when the electrical audiometer is used with an ear piece similar to that of a telephone. To prove this, a number of subjects in whom hearing in one ear was totally destroyed were tested with the audiometer. It was found that in every case a considerable degree of hearing was perceptible when the defunct ear was tested. This was due to the hearing being transmitted to the opposite normal ear by bone conduction, which immediately ceased as soon as the ear piece was lifted away from the head, showing that the tones were not being conveyed by air conduction. In these cases the patients all lateralized the hearing distinctly to the normal ear. Several case reports were given in which total destruction of hearing in one ear gave partial results with the audiogram.

The writers concluded that the audiometer cannot be used as a means for determining the hearing in each ear separately in those cases in which the defect in hearing is marked, requiring an increase of intensity for stimulation for the patient to hear so that bone conduction becomes a factor.

A long series of audiograms made from patients having extensive defects in hearing in both ears showed a tendency of the curves to follow a parallel course, demonstrating that bone conduction is an important factor, and that the two audiograms are mainly a record of the hearing in the ear in which the hearing is less impaired.

The audiometer is an improvement over previous methods in that it is a means for quantitative testing in the hearing of the several parts of the tone range, and may be of interest to those concerned with problems of physiology of hearing; however, "there is very little gained by an examination of the audiograms, that is of practical use to the otologist, in ascertaining facts which have a practical significance." Defects for the lower and the higher tones which have an important clinical bearing can be more readily and accurately determined by means

other than the audiometer. For the lower tone defect, the tuning forks give more accurate determination, as they can be used for testing each ear separately by air conduction; whereas the audiometer gives misleading conclusions. The audiometer enables one to determine quantitatively defects in hearing for the middle of the tone scale which is only of slight clinical importance. The use of the audiometer for determining the percentage loss of hearing in forensic cases is not applicable in that the actual handicap from a partial loss of hearing may not bear any relation to the percentage loss, as shown by the audiogram. "It is the voice tests alone that have any practical value." If the percentage defect as shown by the audiogram amounts to 70 or 80 per cent for the tone range outside that part used for hearing the spoken voice, the actual handicap may be only from 5 to 10 per cent as far as the spoken voice is concerned. "The audiometer is a mechanism of some value for studying the physiology of hearing, but so far, has been shown to be of very little practical value to an otologist."

This interesting work brings out many important points in the relative value of tuning forks and audiometer, which I believe confirm opinions held by many otolaryngologists.

Langenbeck [5] cited von Eicken's statements that damping of the lower frequencies permits better amplification of the hearing at the higher pitches. Trendelenburg showed that when sounds from highly amplified loud speakers reach a certain intensity, they cause a sensation of dulness in the ears and interfere with proper understanding of speech. With the greatest intensity of sound amplification, pain was felt in the middle ear, and the sounds were entirely misunderstood. He ascribed these phenomena to the formation of combination tones in the ear due to the great intensities employed. "This may explain the masking effect described by several American investigators."

The fact that the low frequencies in speech display far greater energy and that the high pitches show only slight intensity probably explains why a partial damping of the low frequencies when greater amplification is used prevents the production of combination tones the presence of which may mask the high pitched formants.

Sell [6] stated that it is a well known fact that most patients with impairment of the conduction apparatus can easily use the telephone, even when the hearing for the unaided voice is much diminished. Since

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5. Langenbeck, Bernard: Attempts at Improvement of Hearing, Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenh. Aertze, June, 1927; Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:356, 1927.

6. Sell: The Significance of the Connection Between a Source of Sound and the Ear, Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenh. Aerzte, June, 1927; Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:455, 1927.

one must assume that a certain reaction follows a corresponding stimulus (and we are considering only pure cases of defects of the middle ear and are assuming that the inner ear is normal), it is necessary to explain why with a defective conduction apparatus incomparably less energy is transmitted to the nervous mechanism when hearing is unaided than when it is aided by the telephone. It is reasonable to assume that the abnormal middle ear takes up little energy from the direct air-borne sound. Because of thickening and other changes in the mucosa or drum membrane, the defective conduction apparatus actually reflects the greater part of the sound energy. It is practically tone resistant (Schallhart), that is, it responds to a great pressure amplitude with only a small amplitude of motion, whereas the apparatus for the normal middle ear responds easily to externally applied amplitudes. The difference between ordinary hearing and that aided by the telephone is that in the latter instance the relationship or connection between the source of the sound and the ear is incomparably more intimate. The amplitudes are, so to speak, forced on the ear, and the latter is unable to reflect the incoming energy.

A receptor of sound functions best when it reflects as much sound as it absorbs. The defective middle ear, however, absorbs little energy and reflects most of it. The ordinary microphonic hearing aids are valuable, not only because they amplify the intensity of sound (remembering that in defects in the middle ear there is a favorable compensation because the close connection with the ear gives a greater transmission of energy to the inner ear), but because the usual devices favor the lower frequencies. But in cases in which the impairment in hearing is due to a nerve defect the connection with the ear is not the deciding factor and aids to hearing are of no avail; the predominance of the lower tones favored by these devices is a distinct disadvantage. "This is shown in clinical application, for in the nerve cases there is almost always worse hearing with the usual appliances than without them."

It is possible, however, to construct microphones which amplify all frequencies, even the highest. The author has built such an apparatus, which is said to have properties similar to those of a normal ear. With this, splendid results in the betterment of hearing are said to be obtained even in cases in which the defective hearing is due to impairment of the auditory nerve.

The authors [7] sketched the historical development of audiometers, giving due credit to American investigators, such as Seashore, Fletcher and others. They stated that they have not had any personal experience

7. Kahler, O., and Ruf, C.: Clinical Tests with the Electrical Tonesiren of Schwarz, Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenh. Aerzte, June, 1927; Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:439, 1927.

with the American apparatus; but they are inclined to believe that they do not sustain a certain pitch, that some of them do not cover the entire tonal range, that some give only the octaves or half octaves and that they no doubt present the disadvantage of excessive price.

They quoted Schaeffer's requisites of a proper audiometer; namely, that its tones should be as free as possible from overtones, that its range should include all frequencies from the lowest to the highest of the limits of hearing, that the tone intensity should be capable of variation with sufficiently wide latitudes and should be accurately measurable. Schwarz' oto-audion is said to fulfil the first and second requirements; but the intensity cannot be accurately measured, and there was inconstancy of the intensity and pitch. The latter defect evidently is due to the lamps employed and has been partially overcome by means of the voltometer, which permits corrections of the readings.

The authors stated that so long as there is no definite uniformity of tones and intensity all tests and results in the form of hearing curves are inaccurate. In 1921, Griessman suggested an audiogram showing both intensity and pitch, such as are produced by the American instruments. These curves show the threshold for each tone used. The authors presented curves of normal and pathologic cases and stated that the results were well in accord with the tests made with the tuning fork. They also said that thus far their apparatus does not permit the testing of bone conduction.

I have made no effort to abstract the purely physical considerations of Schwarz' oto-audion which is contained in the latter's article just preceding the paper by Kahler and Ruf. It is indeed novel and refreshing to find a paper such as this one which at least calls attention to the great work of the Americans in the development of audiometers, and which presents a thoroughly comprehensive bibliography of the subject. Would that more European writers read the extensive and in many cases advanced literature of the otolaryngologists of the United States!

The author [8] summarized his experience of the past two years with aids to hearing which are based on apparatus consisting of microphones with amplifiers. The greatest benefits accrued in cases in which the patients had a decided degree of involvement of the middle ear or conduction apparatus, less benefit when only a slight impairment was present, still less improvement when there was impairment of the middle and inner ear and the least betterment when a definite derangement of the auditory nerve was found. In the latter cases, great efforts were made

8. von Eicken, C.: Tests with Sound Amplifying Devices, Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenh. Aerzte, June, 1927; Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:354, 1927.

to secure some improvement in hearing. Zwaardemaker suggested that the appliances be so constructed that great amplification would occur at the pitches for which there was the greatest defect in hearing. By means of filters, the lowest tones were eliminated, and maximum amplification of the high pitches was permitted. It was observed that the damping of low frequencies permitted considerable improvement in cases of impairment of the auditory nerve. While this damping of the low pitches was not actually necessary in involvement of the middle ear, it made the appreciation of details of speech more distinct. The retention of the low frequencies, according to these observations, seems to act as an impediment to the understanding of speech rather than as an aid to it, especially in cases requiring marked amplification.

I agree with the author with reference to the types of impairment in hearing and the degree of improvement with various kinds of aids to hearing. With the electrical devices especially does one observe that patients with impairment in the conduction apparatus are helped much more than those who have involvement of the inner ear.

McKelvie [9] suggested a device for accurate testing with the watch. It consists of a band with a buckle which is placed around the head just above the ear. A length of tape marked in inches is attached to the band on both sides just above the ears. The tape is passed through the ring of the watch, which is moved toward or away from the ear, care being taken that the ring of the watch does not come in contact with the tape as this would obviate sound conduction. The distance is measured at which the watch is heard, and a record is kept for future reference.

The objections I have had to testing with the pocket watch is that no two watches have the same pitch or intensity, and that watches produce noises and not pure tones. Of course, the watch may be employed as a rough indicator of gross changes in hearing, and since it is an always easily available apparatus, it is much favored by those who either do not possess good tuning forks or do not desire to use them.

Yates [10] stated that the degree of deafness should be defined in exact terms; this is especially necessary in those cases in which one is recording the results of treatment. The main factors in the sense of hearing are: (1) ability to hear simple tones (which is the primitive form of hearing possessed by all the lower animals) and (2) power to interpret the sounds of speech (which is higher in the stage of evolution

9. McKelvie: An Aid to the Recording of the Results of Hearing Tests, J. Laryng. & Otol. **43**:532, 1928.

10. Yates, A. Lowndes: Methods of Estimating Certain Alterations in the Middle Ear by Means of Quantitative Tests of Hearing, Proc. Roy. Soc. Med. **21**:863 (March) 1928.

and is found particularly in man). Therefore in the derangements of the mechanism of the ear, the power of interpretation of sound may be reduced more than the ability to hearing simple notes.

In testing the patient for conversation, the distance at which the examiner's voice can be heard by the normal ear should be stated so that the hearing for conversational voice can be noted; if necessary, this should be stated in percentage. A means for quantitative testing by the tuning fork is necessary in addition to that for conversation. Lord Rayleigh's book on sound has the first record of such an attempt, but certain alterations are necessary to make the tests useful for the otologist. The principle of quantitative testing is to find the quarter intensity period of a tuning fork heard without resonance and damped constantly to a similar degree, as if held closely to the tragus. The distance chosen is one-quarter inch from the tragus. To determine approximately the quarter period of a fork, the fork is held first at a distance of 12 inches; when no longer heard, it is held one-quarter inch from the tragus, and the number of seconds heard there are recorded. This is repeated at distances of 6, 3 and 1½ inches. Applying the formula dealing with the decay of bodies in vibration, the zero point of hearing was found to be one-half inch inside the tragus. From these figures the distance at which the fork can be heard by the normal ear in any second of its ordinary vibration can be calculated. In this way, it is possible to make a table for all the tuning forks; then by taking the time for which the observer's normal ear can hear the tuning fork after the patient ceases to hear it, the distance at which the normal ear would have heard the fork at the moment the patient ceases to hear it can be determined. This can be converted to percentage, and the patient's diminution for hearing distance will be known in percentage. These tables can be changed to a graph recorder, which accomplishes the same results semi-automatically. The method is fully explained.

The graph recorder is a card the same size as the graph form over which it is placed. Both forms are illustrated in the paper. The ordinates represent the degree of diminution of hearing, in percentages, for both air and bone conduction. The abscissas represent the pitch of sound. The graph recorder is slit opposite each of these numbers throughout the length of the ordinate in question. Along the right side of the slit are numbers representing the number of seconds the observer's normal ear hears the fork after the patient ceases to hear it. The position of these is determined by a formula given in the paper. For instance, the *C 2* (32 double vibrations) fork is held one-fourth inch away from the tragus of the patient, and when he no longer hears it, the examiner listens to it at one-fourth inch distance and determines the number of seconds he hears it longer than the patient did, which,

for example, may be 16. A mark is made on the graph through the slit corresponding to the fork used and one opposite the number of seconds on the scale 16. This gives the percentage diminution of the hearing distance for this pitch on the graph. This is repeated with the other forks and the Galton whistle, monochord or audiometer for 2,048 double vibrations or above. For bone conduction, the figures on the left of the slit are employed. When bone conduction is increased, the observer listens to the fork in the air, and the number of seconds he hears it by air after the patient ceases to hear it over the mastoid indicates the position he marks on the graph. When bone conduction is diminished, the additional time the observer hears it over his mastoid after the patient ceases to hear it is the number opposite which he makes a mark on the graph. Several graphs accompany the article to demonstrate the results obtained. It was found that the ratio of acuteness of auditory perception could be measured by physical methods in any physical laboratory, and that the results and differences could be calculated by any one skilled in the business use of logarithms. Complete examination of both ears required about twenty minutes.

I have not had any experience with this method, and I cannot properly evaluate it. One must remember that the intensity of sound varies inversely as the square of the distance, so that a slight difference in the distance at which the fork is held from the ear makes a great difference in intensity; unless a fixating apparatus is used, it is impossible to have the fork held steadily and exactly at a certain point, especially when such small distances as one quarter of an inch are employed. The inverse square law applies to a point source of sound in an open, unconfined space, whereas in a room the walls and furniture give standing wave systems, reflection, etc.; so it seems to me that one cannot secure accurate results reckoned in percentage of hearing ability such as given by the author. Furthermore, it has always appeared to me preferable to have an objective standard of comparison rather than a subjective one. As I have stated in various papers, it seems better to determine by many tests on normal subjects what the average duration of hearing for a certain fork is and then merely to compare that with the time it is heard by the patient rather than to use one's own air or bone conduction, since that may be diminished or increased or may vary from time to time.

TESTS OF HEARING

One thousand one hundred and seventy-one children tested a year ago were again similarly tested with the audiometer with five receiver holders, which made possible the testing of forty children at one time. The survey was conducted in two and one-half days. The results obtained indicate that about one third of all the children selected in this

survey had borderline cases. Fowler and Fletcher [11] suggested that six sensation units instead of nine be taken as indicating a definite defect in hearing. If this is done, the number of borderline cases as well as the total number of cases would be materially increased. The patients with between six and nine sensation units need attention and would derive great benefit from proper treatment as shown by otologic examinations. If periodic tests were made throughout the year, the results for the children in this class would fluctuate between those for the normal and those for the deafened classes, owing to the possibility of observational errors and the changes in the children's hearing due to cold or other causes. There is a considerable number of cases in which the patients show a definite improvement during the year without any definite medical or surgical attention. There is also a large group of children that show a definite decrease in hearing ability from year to year who should be given special medical attention. In order to determine which patients have a temporary impairment that may improve, and which have a more severe and progressive condition, careful annual examinations of the hearing should be made, and special attention should be given to all children who show any signs of ear trouble at any time. By means of careful records over a period of years, valuable information will be obtained regarding the proper methods of conducting otologic examinations and managing and treating deafened children. In addition, valuable data may be obtained on the etiology of progressive deafness.

Work of this kind is timely, and the research done by Fowler and Fletcher deserves the highest commendation. It takes much time, effort and perseverance to carry out numerous tests over so long a period.

Macfarlan [12] stated that there is a demand for standardization of the hearing tests which eventually will be as useful as the tests of vision are to the ophthalmologist.

The standard unit of hearing should be a single tone or tones of known pitch and intensity that have been tested with reference to hearing under standard fixed testing conditions. Variations in the standard tests and their causes should be emphasized and defined. The tuning forks at present appear as the most practical instruments with which to build up a standard, because they give the purest tones of fixed pitch. If they can be reasonably controlled as to amplitude, it is possible to determine the exact amount of loss of hearing of a patient when the dampening factor of the fork is known. The normal hearing time

11. Fowler, E. P., and Fletcher, Harvey: Deafened School Children: Detection and Treatment, J. A. M. A. **91**:1181 (Oct. 20) 1928.

12. Macfarlan, Douglas: Standardizing the Tuning Fork, Arch. Otolaryng. **7**:234 (March) 1928.

of any given tuning fork which is struck a standard blow can be obtained by examining a large series of persons with normal hearing. A standard blow struck once is the preferable method. A brass rod 8¾ inches long and 3/16 inches square, having rubber tubing on one end, is allowed to swing from a horizontal to a perpendicular position, striking the fork near its extremity. When the rod rebounds, the fork is withdrawn for the testing. The force of the blow is directly proportional to the radius described by the rod swinging to the perpendicular position. Results obtained with this standard blow using a Koenig *B* (488 double vibrations) and a *c 1* (256 double vibrations) fork show practically a constant tone when these forks are heard in repeated tests on the same person. The knee blow in the same tests give results of greater variability. This is due probably to the inability to strike identical blows repeatedly. The conformation of the knee and the clothing on the knee varies with different examiners and introduces additional variables in the test.

Forks of relatively low pitches, as 256 or 512 double vibrations, are recommended for routine testing of the length of time a tone is heard, because they produce hearing tone long enough for practical timing purposes. Each fork has its own normal hearing time. When a tuning fork can be heard longer than one hundred and twenty seconds by air, it is unsatisfactory because the end-point of hearing is not distinct, and the factor of auditory fatigue must be considered. To determine the percentage of hearing for the pitch used, the dampening factor of the time fork must be known. The dampening factor shows the rate of "dying down" of the fork, with a sudden initial drop, followed by a more gradual logarithmic decline. "This declination" according to Sonnenschein, "is different in various forks of the same pitch, but practically the same for any fork, unless there is a great variation in the intensity with which the fork is struck." This factor is designated by the Greek sign "delta" and is used in all combinations of hearing time; as, for example, a fork, normally heard sixty seconds, is heard only thirty seconds by a person who is hard of hearing. The loss in hearing is the difference in time, thirty, multiplied by the "delta," the damping factor of the fork.

Equal steps of increasing loudness represent sound force that is actually increasing at each step, ten times that of the preceding step. For this reason, Fletcher proposed that hearing be measured by units, called "sensation units." A sensation unit corresponds to a fractional change in the intensity which is approximately the smallest that the average ear can detect. The hearing loss (H.L.) in sensation units is defined mathematically by the equation H.L.—10 log $\frac{I}{I_0}$ when I is the intensity of the sound just audible to the person being tested and

Io that audible to a person of normal hearing. To reduce the results of tests with the fork to a percentage of hearing loss, the hearing loss is multiplied by a constant for the various pitches of forks and bears relation to the varying audibility to different pitches with varying types of sound. "With the standard fork blow, with surveyed forks and with an identical technique in making examinations, the opportunity for definite, intelligible testing is within the reach of every otologist."

I feel (and this has also been stated by Harvey Fletcher) that with good forks supplied with the "constant" of damping, the same curve showing loss of hearing figured in sensation units may be obtained as is obtained with an audiometer, but it requires more time. On the other hand, a moderate number of forks costs much less and is more easily transported.

Macfarlan [13] reported a peculiar case of diplacusis, in which the false note was heard only in the left ear and had the pitch of the second semitone above the true tone. The left ear was deafened somewhat more than the right ear. This attack followed an acute purulent rhinitis, and the hearing tests revealed an impairment of the acute incipient catarrhal type. The diplacusis in this case was peculiar in that it was two semitones instead of a quarter of a tone above the tone as in the majority of cases. All symptoms cleared up spontaneously two weeks after the onset of the cold in the head.

In the cases of diplacusis reported by Shambaugh and Knudsen, there was a positive diagnosis of disease of the inner ear, and not one patient showed any evidence of disease of the middle ear that could be held responsible for this symptom. Diplacusis is characteristic of disease of the inner ear, but in Macfarlan's case there was an involvement of the middle ear also showing symptoms of disturbance of the inner ear. The transitory nature of the diplacusis might be due to some pathologic deposit adhering to the tectorial membrane, as has been suggested by Shambaugh. In this case, the exactness of the harmonic relations exhibited over nearly an octave would require an exactness of placement of a fibrinous deposit that seems rather improbable.

PARACUSIS WILLISII

The various explanations of paracusis willisii were enumerated by Somerville and Scarff.[14] The method for testing and the instrument used were introduced by Tucker and Hastings in 1922. The instrument is a form of wireless oscillator with a basic note of 520 double vibrations.

13. Macfarlan, Douglas: An Unusual Type of Diplacusis, Arch. Otolaryng. **7**:41, (Jan.) 1928.

14. Hastings, Somerville, and Scarff, Gordon R.: Notes on Paracusis Willisii From the Ferens Institute of Otolaryngology, J. Laryng. & Otol. **43**:261 (April) 1928.

A pure tone can be produced by means of a variable condenser, and the pitch can be made to vary from 270 double vibrations to the upper limit of normal hearing. The strength of the signal can be varied from zero to its maximum intensity by using a Wheatstone bridge and by introducing a resistance varying from 1,000 to 10,000 ohms on one side of the bridge. The sound is conducted from the bridge to one of a pair of telephone receivers in a silience cabinet. The disturbing sound when used is derived from an electrically operated, unloaded tuning fork from which the sound is electrically conducted to the head phone and can be conveyed to either receiver.

The reading given by the audiometer is the amount of electric current passing through the telephone necessary to render the sound just audible to the person being tested. As the current is increased, the sound is clearly increased. There are certain difficulties in carrying out the test, because as the test becomes less audible, the person's signals become less certain. The patient's ability to hear the signal is usually improved after a preliminary test, but if the test is continued for any length of time, the power of attention becomes fatigued, and the auditory nerve may also share in this fatigue. Finally, a true end-point is difficult to obtain in some cases in which the patients have marked tinnitus. The subjects who showed the most lowering of the upper tone limit did not require the greatest increase in the strength of the signal to make it heard in the presence of the disturbing noise as would be expected. The authors conclude from their tests that the audiometer provides an accurate method for determining the presence or absence of paracusis and that: 1. The normal hearing person and patients suffering from disease of the internal ear require a considerable increase in the strength of the signal to hear it in the presence of noise. 2. The number of patients who hear better when there is noise appears to be small. 3. A considerable proportion of deaf people do not require as large an increase in the strength of the signal in the presence of a noise as do normal people, and therefore their disability appears proportionately less. 4. When there is noise in one ear, some patients hear the test sound better in the other.

Mygind [15] offered an explanation for the observations reported by Hastings and Scarff on paracusis willisii. When a sound penetrates an obstruction, the less energetic lower tones are more weakened than the tones of higher frequency. The obstruction existing in the middle ear and mixed deafness suppresses more or less the original tone of the disturbing sound, leaving the overtones more unaffected the higher the pitch. As the original tone becomes sufficiently weakened, the signal

15. Mygind, S. H.: On Some Acoustic Phenomena in Connection with Paracusis Willisii, J. Laryng. & Otol. **43**:543 (Aug.) 1928.

does not require the same degree of increase to be heard in the normal subject, thus producing a relative paracusis. If the obstacle to deep tones is sufficient, an overtone which is not independently perceivable may reinforce the signal tone so that it is heard at a lower threshold than ordinarily perceived, producing absolute paracusis. The overtone need not coincide with that of the signal tone. This is explained by Mygind's theory of hearing which states: "The area of the organ of Corti stimulated by each single tone has a considerable extent, beginning at the point of the maximal stimulation of the tone one octave below, and ending at the point of maximal stimulation of the tone one octave above." According to this, only one of the overtones with its area of stimulation need reach the stimulated area of the signal tone to reinforce it slightly. The result is either a comparatively slight increase in the threshold of the signal, a relative paracusis, or a lowering of the threshold, an absolute paracusis. Crossed paracusis is a result of the obstruction offered by the bone when the disturbing sound is conducted to either ear. This passage by bone conduction acts as a filter suppressing the disturbing tones and favoring the arrival of the overtones to the ear tested, where one or more of them may reinforce the signal tone. Raising the pitch of the real or the essential signal tones made no difference because of the reinforcing overtones also present.

Many theories of paracusis willisii have been formulated, but, as suggested by Troeltsch many years ago and recently by Shambaugh and others, the phenomenon is probably due to the fact that the person who is hard of hearing is masked for the low tones which disturb the person who has good hearing. In order to overcome noises, the latter speaks louder, and hence the otosclerotic person hears better, but only because the speaker uses greater intensity of voice.

ACOUSTIC METHOD

The acoustic method, according to Goldstein,[16] is the "stimulation" or education of the hearing mechanism and its associated sense organs by sound vibrations as supplied either by voice or by any sonorous instrument. This special pedagogy has been seriously studied, critically tested and carefully applied, and its fundamental principle of vibratory stimulation has been generally recognized as having a practical and definite place in the teaching of the deaf. An effort has been made to establish a system of progressive exercises to comply with the demands of speech training and a better understanding of the physiology of the ear and psychology of the deaf child. The remnant of hearing found in about 70 per cent of children with biologic congenital deafness is the

16. Goldstein, Max A.: Evolution of the Acoustic Method, Ann. Otol. Rhinol. & Laryng. **37**:379 (March) 1928.

objective of this special pedagogy. This type of case offers the most promising results. A working system was evolved in which the human voice was used. The various steps which form the basis of these training exercises are as follows: (1) vowel differentiation; (2) introducing—first—consonant elements and their combinations with the vowel elements; (3) addition of diphthongs to the hearing vocabulary of the pupil (the consonant palatal elements, m and n, are next applied in their combinations with initial and end vowel elements); (4) frequent and intensive drills of words made up of these elementary sounds of vowels and consonants, and (5) addition of the remaining consonant elements in specially arranged successive exercises and in relation to their range of auditory perception—words, phrases and sentences are then built of elementary combinations of speech in the order in which they have been practiced.

Specially arranged individual charts are used to record every step in the progress of the pupil. A graduated systematic series of exercises and fables based on results for the normal ear has been constructed and studied in conjunction with the pathologic processes and psychology of the deaf child. This is offered as a working plan and is not free from imperfections.

The plan is described and explained in detail. Goldstein stated the belief that the many unsuccessful attempts and indifferent results in the use of the acoustic method are due to the aimless and nonsystematic form of procedure used, which has discouraged both teacher and pupil and has given rise to many misconceptions and misunderstandings regarding this special pedagogy. He predicted for the acoustic method a new era for the deaf when its untold benefits are fully realized.

Credit in highest degree is due Dr. Goldstein for his ingenious, untiring and masterful work in the difficult problem of educating the deaf child. Surely in no other pedagogic endeavor is knowledge of the various factors involved, perseverance, patience and love of mankind needed more than it is in such monumental efforts to help the unfortunate deaf.

One striking phenomenon seen in a large percentage of hearing graphs is a marked dip in the curve between 1,000 and 5,000 cycles occurring frequently in both normal and abnormal ears.[17] The significance of this is unknown. Marked deficiencies of hearing limited to one, two or two and one-half octaves occur in otherwise normal ears irrespective of any detectable defects in the conduction apparatus. In one case cited the patient did not complain of any impairment in hearing, but she showed an area of deficiency extending from 3,251 to 5,793 cycles,

17. Fowler, Edmund Prince: Marked Deafened Areas in Normal Ears, Arch. Otolaryng. **81**:151 (Aug.) 1928.

which is the smallest thus far seen. The ear not being tested must be made deafened to the testing intensity; otherwise it will be the one that partly or wholly hears the sound. The hearing of the left ear was high normally, but the right ear showed sound definitely absent near 4,000 cycles, and the threshold of hearing appeared suddenly.

Comparative loudness showed that the loudness of tones (near 4,096) of from 10 to 25 sensation units above the threshold in the nonaffected ear, appeared the same loudness as 5 sensation units above the threshold in the affected ear. At frequencies just below the brims of the dip, the ear heard all the frequencies double. At 3,400 cycles and 4,700 cycles these changed to a clear and single tone.

The four explanations of these limited deafened areas which theoretically seem logical are: The curve dip is due to (1) some limited central or cortical lesion in an area presiding over these frequencies; (2) a defect in the nerve fibers to the tiny section of the basilar membrane which normally detects these frequencies; (3) a defect in the terminal nerve apparatus (Corti's organ) or (4) an antiresonance somewhere in the conducting mechanism.

The observations in this case suggest static friction somewhere in the conduction path, probably not in the middle ear, because it would affect several other frequencies, and these would then also be lowered, which was not the case.

If the cochlea is the seat of trouble, the organ of Corti must be the defective part; otherwise all the lower frequencies would also be lowered. If the organ of Corti is producing these changes, it is probably due to looseness or altered coaptation in the rods of Corti or in the hair cells and tectorial membrane. Some day it will be known whether or not there are other normal ears like the one in this case.

A study was undertaken by Drury and Gallivan [18] to determine standards of performance in various groups of persons who were to be regarded as having hearing powers above the average due to either superior health or specialized training influencing aural acuity. Seventy subjects, of whom forty-six were males and twenty-four were females, were examined with the no. 1 and no. 2 audiometer. Tests were made on seven groups of ten each, consisting of ten telegraphers, ten telephone operators, ten expert piano tuners, ten ornithologists and twenty college athletes (ten boys and ten girls), who were used as controls. The examiners found the middle speech area one-third larger in the male athlete and in the telegraphers and only 25 per cent larger in the rest of the groups. Both ears were seldom exactly alike in sensitiveness, although differences were not evident objectively. In quality analysis, however, the two ears seem to approach each other more closely in their response. The acuity of an ear varies from time to time (or even in the same day) as much as 10 sensation units. In most cases the normal quality area was uniform and extended throughout all the intensities.

18. Drury, D. W., and Gallivan, Dorothy: Quality Hearing, Ann. Otol. Rhin. & Laryng. **37**:661 (June) 1928.

Seventy per cent of the subjects heard distinctly the highest frequency in one or both ears. About 10 per cent of the total number did not have any ability of quality differentiation. The writers concluded that a determination of differences in quality hearing in persons with superior acuity and training offers the possibility of significant and characteristic limitations in certain disease conditions. Some hearing mechanisms that seem normal may show small abnormal quality areas. A certain number of people with normal acuity are unable to determine quality differences and are unaware of their limitations. Pure tones are essential in making these tests.

Some years ago, Seashore did considerable work in an endeavor to determine criteria for use in the selection of vocations. Drury and Gallivan's paper is a valuable contribution along the line of clinical investigation.

Emerson [19] stated that following acute exacerbations of an infective process involving the tube and middle ear, and during its resolution, any type of hearing test may be obtained, but when the case becomes chronic, there is a gradual clouding of tone perception which proceeds in an orderly fashion throughout the course. Lowered bone conduction, with the raising of the low limits, is an indication of this regular progressive course. The end-result in all cases is nerve deafness, which is made worse by an intercurrent disease or any local or general infection that reduces the resistance of the patient. It never resembles a typical case of otosclerosis, and never varies from its own characteristic development in slowly progressive cases. An obstruction in the middle ear does not modify the results of a typical hearing test in a chronic case of deafness, as pathologic changes in the middle ear follow the loss of tone perception.

Dr. Emerson has long held that many conditions in the ear rest on an infectious basis, and he has written a number of excellent papers on this subject.

TESTS ON SCHOOL CHILDREN

The authors [20] presented an extensive statistical report of the results obtained in examinations of 3,120 deaf children. The significance of hereditary syphilis as an etiology of congenital and acquired deafness was investigated. They concluded that syphilis is an unimportant item in this country, at least in the causation of deaf-mutism, since only two of 396 pupils in one school showed positive Wassermann reactions.

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19. Emerson, Francis P.: Some Mooted Points in Sound Conduction and Perception During the Course of Chronic Progressive Deafness, Laryngoscope **38**:185 (March) 1928.

20. Shambaugh, George E.; Hagens, E. W.; Holderman, J. W., and Watkins, R. W.: Statistical Studies of the Children in the Public Schools for the Deaf, Arch. Otolaryng. **7**:424 (May) 1928.

Although there are more males than females with acquired and congenital deafness, the difference is so small that sex need not be considered an item in the etiology of congenital or acquired deafness. The most dangerous period for the development of severe deafness in young children is before they have reached the third year, as shown by the statistics. The great number developing loss of hearing during early childhood (between 5 and 10 years of age) is probably due to the great incidence of such infectious diseases as scarlet fever and measles, particularly during this period. These produce deafness, either because of severe otitis media with secondary involvement of the labyrinth or because of toxic neuritis of the eighth nerve. The authors find a remarkable dropping off in the number of cases of acquired deafness after the age of 10.

Investigating the etiology of these cases, they found that 209 cases followed meningitis; scarlet fever caused 100 cases, measles 97, influenza 91, suppurative otitis media in which mastoidectomies had been performed 66 and infantile paralysis 37; syphilis was given as a probable cause in 24 cases, mumps in 12 and otosclerosis in 6. In the cases of meningitis in which the deafness developed in connection with otitis media, the vestibular responses were absent. It seems, therefore, that otitis media associated with meningitis is likely to destroy all vestiges of function of both the vestibular and the acoustic mechanism. In 152 cases of total deafness resulting from meningitis, not associated with otitis media, 32 patients gave responses to the vestibular tests. This is interesting, since it has been assumed that when meningitis invades the labyrinth of the ear and produces total deafness, the same process carries with it complete destruction of the functions of the vestibular mechanism. When meningitis leaves vestiges of hearing, it may destroy the vestibular mechanism in a few cases. Total deafness resulting from scarlet fever, with otitis media, does not always produce complete destruction of the vestibular mechanism. In 29 of 100 cases with deafness following scarlet fever associated with an otitis media, vestiges of hearing were found; most of the patients gave positive vestibular responses. These observations may be due to an involvement of the nervous mechanism or neuritis of the eighth nerve, instead of to a diffuse suppuration of the labyrinth, which otolaryngologists are inclined to believe produces total and permanent destruction of all function of the labyrinth. A toxic neuritis may produce total or partial deafness. The majority of cases of total deafness will also show total destruction of the vestibular mechanism; when vestiges of hearing are found, vestibular responses will usually be present. Measles, like scarlet fever, is capable of producing toxic neuritis of the eighth nerve without an associated otitis media. Mumps may also produce toxic neuritis of the eighth nerve, causing total or partial destruction of hearing or of the vestibular

mechanism. In six of twenty-four patients with deafness following fracture of the skull, vestiges of hearing and vestibular responses were demonstrable. These observations were a surprise, since in basal skull fractures producing deafness one expects to find total destruction of hearing.

Statistics in relation to the conditions of the tonsils and adenoids were analyzed and show that although they are a factor in producing mild cases of deafness in children, they cannot be held responsible for the deafness found in these children, which is of the inner ear type. A table covering 723 cases, in which heredity and consanguinity seemed to play a part is presented in this article. Six hundred and four of the patients gave positive vestibular responses, bearing out the view that the vestibular responses are more likely to remain to some degree in congenital deafness. The vestibular responses were found much more frequently in cases of partial deafness than in those of total deafness. Various problems were analyzed in connection with the defect in hearing. Regarding the status of hearing, over 47 per cent were cases of total deafness and over 52 per cent were cases in which a remnant of hearing was still present. In almost 60 per cent of the totally deaf patients the condition was of congenital origin, and in 64 per cent of the patients who were partially deaf the impairment in hearing was also of congenital origin. Investigations of the vestibular reactions showed that in those cases of congenital deafness in which the hearing was not entirely destroyed, the vestibular responses are more likely to be preserved than in cases of congenital total deafness. In cases of acquired deafness, with vestiges of hearing present, vestibular responses are more likely to be present than absent.

The Schwabach test was carried out in 2,979 cases. Bone conduction appeared entirely absent in 2,040, distinctly shortened in 795, normal in 94 and actually prolonged in 50. The normal or prolonged bone conduction may result when there is a combination of obstructive deafness of the middle ear with only a partial superimposed labyrinthine degeneration. One thousand five hundred and fifty-six of the 2,040 children without bone conduction showed remnants of hearing with the audiometer. Fifty-six of the 795 children in whom bone conduction was distinctly diminished were found to be totally deaf with the audiometer, and the others showed remnants of hearing. Ninety-two of the ninety-four with normal bone conduction had a remnant of hearing as shown by the audiometer. Two of fifty patients in whom bone conduction was prolonged longer than that of the normal person showed a total defect in hearing by the audiometer. This may be explained by the possibility of these two children confusing actual bone conduction with jarring produced by the tuning fork in the Schwabach test.

The Rinne test was recorded 3,231 times. Four hundred and fifty-six children gave a positive Rinne reaction, 270 gave a negative reaction and 2,505 gave an absolute (or "infinitely") negative reaction. In the cases in which there is a total loss of hearing in one ear and a remnant of hearing in the other, an absolute negative Rinne reaction is always obtainable on the side of the total deafness. In 210 children, the Rinne reaction was positive in only one ear; in 246, it was positive in both ears. In testing these children with the audiometer, five of the 210 did not show any hearing with the audiometer, while 204 gave remnants of hearing. Only three of the 246 having positive Rinne reactions in both ears showed a total defect with the audiometer test. Two hundred and fifty-seven of the 2,503 with absolute negative Rinne reaction were unilateral, and 2,248 were bilateral.

The audiometer found remnants of hearing in practically 100 per cent of the cases. Five hundred and eleven of the 2,248 children with an absolute negative Rinne reaction in both ears showed a total defect, and 1,736 revealed remnants of hearing when tested with the audiometer. Most of the children who had remnants of hearing heard below 2,000 double vibrations, but none had preserved remnants of hearing above 2,000 double vibrations only. There is a confusion between tactile sensations and audition in the bone conduction tests with tuning forks or when testing the lower part of the scale with the audiometer when bone conduction cannot be excluded. This is easily understood when one considers the auditory sense as being only a highly specialized tactile sensation. In comparing the relationship of the audiometer tests with speech defects, it was found that 113 of 505 children who showed total deafness in all the functional tests had no marked defect in speech. Nine hundred and fifty-four of 2,452 children showed remnants of hearing with the audiometer when other tests were negative, while thirty-two showed hearing in the other tests, but no hearing with the audiometer. This hearing in the other tests and without the audiometer may be especially for bone conduction and due to confusing tactile sensation with actual hearing. About one half of the children in whom hearing was demonstrated showed a marked defect in speech. Children with marked defects in speech often show remnants of hearing in part of the tone scale that is above and below 2,000 double vibrations, which is essential for the hearing of the voice. Marked defects in speech were observed in only seventeen children, who showed a total deafness with the audiometer tests but remnants of hearing in other tests. Investigations of the vestibular reactions showed a small number of children (twelve) who responded to the turning tests and not to the caloric tests. Eight were cases of congenital deafness and four of acquired deafness. Fifty-nine of one hundred and twenty cases showing an absence for both turning and caloric reactions were congenital and sixty-nine were acquired.

It is difficult to evaluate in an abstract the stupendous work involved in this statistical study. Its wealth of material should furnish food for thought and study in the investigations of the hearing of millions of school children.

Reuter,[21] testing the intensity of words used in hearing tests, employed apparatus and methods suggested by Hogewind in the physiologic laboratory at Utrecht.

Paraboloid concave mirrors of brass were set in a frame, the concave surfaces facing one another. The center of the second mirror lies in the axis of the first mirror. The receptive apparatus is a brass funnel behind which is an electrically lighted Rayleigh mirror, the reflections of which are thrown on a scale which shows the deflection of the mirror. To obtain the proper distance between the mirrors, a continuous tone produced by an organ pipe manipulated by compressed air is produced, and the mirrors are moved until the maximum intensity is shown on the scale. The mouth is placed in the focus of the mirror, and different groups of words are used. It is necessary to speak slowly with even intensity, gradually increased, and there should be a slight pause between the individual words, so that the Rayleigh mirror may come to a state of rest before being again deflected by the following word. In the first place, the words given in the article are German, and it is difficult to give exact English equivalents and thus evaluate the intensity scale given for the German. Second, the difference of intensity could not be avoided, as it is impossible to control accurately the voice and the changes in quality each time.

It is impossible to judge whether this method will prove practical in testing the hearing quantitatively, but aside from the fact that it calls for a rather elaborate piece of apparatus, the idea appears as an enticing one.

INTERPRETATION OF TESTS

The functional tests of hearing are usually relied on to differentiate obstructive from nerve lesions of the auditory apparatus.[22] Otolaryngologists base their diagnoses on certain observations, such as a subnormal reaction of the ear to the higher tones of the scale especially with a lowering of the upper tone limit and a shortened bone conduction indicating nerve deafness. Likewise it is difficult for the ear to sense the lower tones of the scale, especially with a raising of the lower tone limit and a normal or actually lengthened bone conduction indicating an obstructive deafness. The audiograms should show a curve sloping

21. Reuter, C.: Contribution to the Intensity Determination of Hearing Test Values, Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:15 (May 16) 1927.

22. Fowler, Edmund Prince: Theoretical Interpretations of the Functional Tests, Arch. Otolaryng. **7**:606 (June) 1928.

downward from left to right in pure nerve deafness and a curve sloping upward from left to right in obstructive deafness. In a case of combined deafness, a curve in which the right center and left are more on the level should slope a little, if any, up or down. Some of these criteria may be trustworthy in certain cases, but their universal application would be misleading and theoretically at variance with experimental data and acoustic laws.

Acoustically speaking, there are three mechanical factors which by acting singly or together in various ways control the progress of sound waves through any conducting or transmitting system such as the ear. These are: (1) inertia, which impedes acceleration; (2) elasticity, which impedes displacement, and (3) friction, which impedes motion. It can be assumed from the mechanical make-up of the conductive mechanism that an inefficiency at the low frequencies may be due to the elastic restraint of its parts and at the high frequencies because the mechanism is composed of several vibrating parts. There is an elastic give in the connection between these parts and an inertia from weight. In midfrequencies the mechanism is expected to be most efficient, because weight and elasticity counteract each other. This range is determined by the relative size of the parts and their associated elastic constraints. An increase in inertia may occur in conditions such as wax along the handle of the malleus, increase in size of the ossicles from osteitis, deposits of calcium on the ossicles or drum membrane or exudate or cholesteatoma bearing down on the incus and malleus. The weighting down or inertia itself will affect principally the conduction mechanism for the higher frequencies, but changes in elasticity or friction accompanying the weighting may either accentuate or lower this effect, depending on which dominates. This weighting was accomplished experimentally by attaching a flattened shot over the umbo.

The audiograms revealed the higher tones perceptibly lowered and the lower tones little, if at all, affected. Other factors, however, such as dragging the drum membrane slightly downward, alter the pure effect of weighting. An audiogram showing the effect of a shot attached slightly eccentric to the umbo gave a reverse curve. The lowering of the transmission of the high frequencies is caused by the shot being off center with a tendency to stand still, restraining the malleus elastically through the intervening membrane between the shot and the umbo which tends to favor these high frequencies by the increased elasticity.

These two experiments demonstrate how a small mass in a slightly different location may have a definitely reverse effect at the same frequencies. It proves that although the lesion is clearly obstructive, it may either elevate or lower the low or high frequencies. Another audiogram with the weight placed over the umbo shows a decrease in all the

frequencies, except in the extreme upper range where the curve is elevated when the drum membrane is in the horizontal position, probably due to the greater tension of the drum and conducting mechanism when in the horizontal position. The same conductive lesion in different ears may cause exactly opposite effects on the audiogram, and variations from the normal not any greater than those produced experimentally do not give conclusive data for the differential diagnosis of conductive lesions, at least for those confined to the drum membrane or ossicles.

Elasticity may be increased by thick scars, ankylosis or adhesions between the ossicles. Any elastic constraint to displacement impedes the transmission of the higher frequencies. A typical audiogram of this type is shown from a case of obstructive deafness resulting from post-suppurative otitis. In cases of decreased elasticity all the frequencies were affected, but the lower and middle less than the higher frequencies. Decreased elasticity may be produced by atrophic catarrh of the middle ear, by loose ligaments and flabby adhesions. In a case with relaxed drum and exceedingly movable malleus, the audiogram showed a decrease in all frequencies with marked improvement for the higher tones after inflation. In these cases the standard criteria would be misleading. An increase in friction may be produced by densely scarred or edematous drums, closer adhesions between the ossicles, tighter fit of the stapes into the oval window, diminished area of membrana tympani and adhesions between the cellar or attic and the ossicles or drum. Friction generally operates by lowering chiefly the middle frequencies. The increase in inertia and elasticity which lowers the high and low frequencies, respectively, will tend to balance each other in the midfrequencies, leaving friction to dominate. A decrease in friction tends to elevate, at least irregularly, the middle frequencies: this might occur from a stricture or shutting off of the aditus ad antrum.

Audiograms of these various conditions show the difficulty in interpreting the changes even with simple lesions and the assumptions noted. The criteria for differentiating obstructive from nerve lesions may not always hold true, as shown by the graphs from the experimental lesions and cases presented.

The audiogram made either by the audiometer or by calibrated tuning forks will be of invaluable aid to clinical observation and a greater aid than any heretofore used by the otologist for differential diagnosis. It must be used intelligently keeping in mind the theoretical interpretations which explain the phenomena elicited and correlate these to other tests and clinical data.

Undulations in the curves of from fifteen to twenty sensation units cannot be interpreted in terms of obstructive lesions because they may be due to a variety of causes. However, even small variations in audiogram curves, covering several frequencies or showing decided trends may be interpreted in terms of obstructive lesions.

Most physicians are not physicists, but a few of those who are interested in otology have had the privilege of doing work in cooperation with physicists.

Dr. Fowler is one of these fortunate persons; he is furthermore a tireless, persevering and careful worker. His paper shows that certain changes in the drum membrane produce variations in audiometric curves which one would hardly suspect. It is true that in many cases disturbance of the conduction apparatus does not give exactly the observation with the tuning fork or other results that one would expect from the training otolaryngologists have had in this subject. It is a good deal like clinical work in general medicine or in the various specialties, in that cases do not necessarily correspond in many of their details with the textbook descriptions. It is important to correlate the tuning fork and laboratory observations with the data derived by the examination of patients with reference to their history and the state of their various functions. Only in this manner can one arrive at an accurate diagnosis, determine the prognosis and outline the treatment that is applicable in the particular case in mind.

Sonnenschein,[23] in this paper, has written a resumé of tuning fork tests a great deal of which has appeared in previous papers, and therefore no separate abstract is offered at this time. He stated the belief that the most important new item is that concerning the new magnesium alloy forks which have been perfected at the Riverbank Laboratory, Geneva, Ill., by Mr. B. E. Eisenhour. The composition of this metal is said to be 95.6 per cent magnesium, 0.4 per cent manganese and 4 per cent aluminum. These forks have the great advantage that they are light weight as compared with steel which has a specific gravity of 7.7, while aluminum has 2.7 and magnesium has only 1.7. This alloy thus has a specific gravity less than one third that of steel. This is a great advantage in that the fingers do not tire easily when holding the fork while making the various tests. The second and perhaps even more important quality of these forks is the fact that they are rust proof. When forks are nickeled, the nickeling sooner or later peels, and then the vibration of the loose pieces produces adventitious sounds; when forks are not nickeled, unless carefully handled and occasionally oiled, they tend to rust, and then changes in pitch occur. For this reason, the Committee on Standardization of Tuning Forks and Hearing Tests of the American Academy of Ophthalmology and Otolaryngology of which I have the honor of serving as chairman since its formation in 1921, has endeavored to find a rust-proof material suitable for manufacture of forks, since they considered this one of the most important requisites

23. Sonnenschein, Robert: The Rationale of Tuning Fork Tests, Ann. Otol. Rhin. & Laryng. **37**:309 (March) 1928.

of good forks. Those made of magnesium alloy have shown that both for air and for bone conduction they seem to be as good as the best quality steel forks except for the highest tones such as *c 4* and *c 5,* at which pitches the steel forks have a longer duration by air conduction. Magnesium alloy forks have now been perfected in a complete series of from *C 2* (16 double vibrations) to *c 5* (4,096 double vibrations), thus covering the same range as the Edelman series of forks. The price of these magnesium forks is a little less than that of the highest grade imported forks. From most standpoints, the magnesium alloy forks seem desirable, but only wider experience with them will demonstrate whether they will eventually replace the steel forks.

MONOCHORD

Determination of the acuity of hearing for the tones near the upper limit of audibility implies, first, that the tones should be produced for observation, and second, that the intensity measurements should be made in order to determine the threshold of sensitivity.[24] The audiometer has made possible the measurement of the lower range of tones, but is not capable of determining the upper limit of audibility if it is in the neighborhood of 20,000 double vibrations, unless the large expensive research type is employed.

The available instruments capable of producing these high tones for observation, such as the modified Galton whistles, the monochord, modified by Struycken, are unable to make an intensity measurement, unless sufficient distance is used in making the test. This is impracticable because of the limitation of space and the necessary prohibitive construction required to eliminate reflection, standing wave effects, etc.

The monochord offers the possibility of making comparison of the upper limit of audibility by air and by bone conduction, which adds definite information concerning the functioning power of the receptors for these high tones.

Bunch stated the following conclusions: "The upper limits of audibility as obtained by use of the monochord add rather conclusive evidence as to the functioning power of the perceptive and conductive mechanisms of the ear. This is possible, because the upper limit tones are produced with greater intensity than similar tones produced by the audiometers which are available to otologists, and because it offers the possibility of securing determinations by means of bone conduction. Certain cases showing a marked lowering of the upper limit by air conduction can be shown to have a normal upper limit by bone conduction of the nervous mechanism for the perception of these tones." He presents cases and audiograms that support these conclusions.

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24. Bunch, C. C.: The Monochord in Upper Limit Determinations as an Adjunct to Audiometry, Ann. Otol. Rhin. & Laryng. **37**:372 (March) 1928.

AIR AND BONE CONDUCTION

Heermann [25] stated that the study of air and bone conduction as shown in Weber, Schwabach and Rinne tests is the basis of the differential diagnosis between conduction and perception impairment of hearing, but he found, as have all of us done, that occasionally there is an apparently normal bone conduction in disturbances of the inner ear and a positive Rinne reaction sometimes with involvement of the conduction apparatus; therefore exact examination of the upper and lower tone limits is used in the effort to secure more definite results. The usual rule of elevation of the lower tone limit in conduction impairment and the lowering of the upper tone limit in involvement of the inner ear shows so many exceptions, according to Heermann, that the diagnostic value of this testing, especially that of the upper tone limit, is somewhat disputable. He quoted Friedrich Jaehns and Uffenorde to the effect that the determination of the length of hearing of the *c 5* and the *c 4* forks is a valuable substitute for the mere determination of the upper tone limit. Uffenorde especially favors the *c 5* fork, with which involvement of the inner ear shows a much greater shortening than the *c 4*.

Zange is quoted as having frequently observed cases in which the picture of disease of the inner ear was presented on functional testing, but immediate and marked improvement in hearing was shown after inflation; he had furthermore observed cases in which the patients had a definite involvement of the inner ear, but whose upper tone limit was practically normal. The author, at Zange's suggestion, examined twenty-five patients with impaired hearing, in order to reach conclusions regarding the value of the examination with the *c 4* and *c 5* forks. I am inclined to think that those cases in which Zange noted such improvement in hearing after inflation in apparent involvement of the inner ear, were really instances in which the proper function of the round window was interfered with. This type of case is discussed in connection with some other papers.

Heermann stated that he confirmed Uffenorde's observation that with disturbance of the inner ear the percentage of shortening with the *c 5* fork is usually much greater than with the *c 4*. Even with conduction impairment, however, the diminution in hearing for the *c 5* and the lowering of the upper tone limit was so great that the author endeavored experimentally to explain the phenomenon. Since with a spontaneous conduction impairment one cannot definitely determine whether the inner ear is entirely intact, Heermann produced an artificial conduction apparatus impairment by inserting into the external auditory

25. Heermann, H.: The Diagnostic Significance of the Upper Tone Limit and the Hearing for the c-4 and c-5 Tuning Forks in Conduction and Combined Hearing Impairment, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres. **27**:158, 1928.

canal a wax plug which was entirely covered with fine gauze and warmed so that it could be inserted and removed easily. He then tested eight colleagues (selecting them because they would be more likely to give accurate and intelligent answers), making hearing tests both with and without the wax plug in situ. He tested them with the voice, the upper and lower tone limits, the duration of hearing with the *c 4* and *c 5* forks via air and *c* (128 double vibrations) for bone conduction, using the von Struycken monochord for the highest tones. With the artificially produced conduction impairment, there was a reduction for the whisper down to from 20 to 30 cm.; the hearing by air of the *c* was reduced from 40 to 70 per cent, *c 4*, from 40 to 60 per cent and *c 5* from 50 to 60 per cent, while the bone conduction for the *c* was from 150 to 250 per cent that of the normal. The reduction for the high tones varied from 1.5 to 2.5 half tones; for bone conduction, there seemed to be no change in the upper tone limit. The lower tone limit was raised from 1.5 to 2 octaves. The author believes that these results show that neither the upper tone limit nor the *c 5* fork alone gives any data for a definite differential diagnosis. He says that the upper tone limit must always be compared with the lower tone limit, and the *c 5* fork must always be compared with one the pitch of which lies near the lower tone limit; the fork may, at the same time, be used for the Rinne test, for instance, *A* (108 double vibrations) or *c* (128 double vibrations).

The author's general conclusions are: 1. An impairment in conduction apparatus diminishes the hearing for both high and low tones which are not absolutely at either the high or the low tone limits in apparently the same degree. The low tones are thus not diminished more than the high ones. 2. The lowering of the upper tone limit and the shortening of hearing for the *c 5* fork, permit a diagnosis of the disturbance of the inner ear only when it is greater than the elevation of the lower tone limit and the shortening for the *c* fork.

ACUITY OF HEARING

Ruf [26] presented a detailed and extensive paper which does not well lend itself to abstracting. He first discussed the various qualities of tuning forks and the use of the latter in functional testing of hearing. He quoted Schaefer to the effect that for proper testing it is necessary to have the source of sound consisting so far as possible of pure tones with the fewest overtones; the tone range should extend from the lowest to the highest limits of hearing; the intensity should be capable of variation at will, and the degree thereof should be measurable. He then recited in detailed manner the work of the American as well as the

26. Ruf, Camill: Threshold of Hearing and Hearing Acuity, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres. **27**:205 (Sept.) 1928.

European otologists and physicists who have developed the various forms of audiometers. The names of Seashore, Dean, Bunch, Fletcher, Wegel, Guttmann, Kranz and Pohlman were cited; and of the German, Anthon, Fiek, Bruenings, Flatau, Waetzman and others were mentioned.

The author presented many curves, some taken from the American authors and some made by himself. He came to the conclusion that there is hardly any disturbance of the middle ear apparatus which is not accompanied or followed by some lesion of the inner ear. He ascribed the fact that the curves in cases of lesions in the inner ear do not always correspond exactly to changes in the hearing functions to the fact that the peripheral neurons show varying degrees of vulnerability. He stated, for instance, that the nervous and nutritional mechanism supplying the basal turn of the cochlea in which the higher tones are perceived is more easily affected by traumatisms, toxic or otherwise, than are other parts of the cochlea. This is shown by the fact that in the beginning of involvement of the inner ear, perception for the highest tones is first impaired.

CONSTITUTIONAL DEAFNESS

Gottlieb [27] stated that the diagnosis of "constitutional deafness" is made on the following observations: a constant elevation of the lower tone limit, a constantly negative Rinne, an abnormal blood chemistry such as a high or low blood calcium content, a high uric acid figure, a progressive course and a contraction of the visual field for form and color. The circulation of the cochlea is such as to make the central fiber of the nerve vulnerable, as shown by the work of Denjiro Nabeya on the circulation occurring in the cochlea of man. In one type the collateral circulation ceases within the basil coil and beyond that the artery is a terminal vessel. Gottlieb stated the belief that this terminal vessel may be affected by poisonous substances with the production of hemorrhagic extravasations and exudates, which may impair the nerves in the immediate vicinity and cut off the blood supply of portions of the nerve and hearing mechanism distal to it. This accounts for loss of ability to hear the lower tones even in early cases of "constitutional deafness."

The observations of changes in visual fields in otosclerosis as reported by Gottlieb are most interesting, especially from the standpoint of an infectious or toxic etiology.

One fact more than any other which impressed Sturm [28] is that chronic progressive deafness begins in childhood, and that the condition

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27. Gottlieb, Mark J.: Constitutional Deafness. 1. Definition. 2. Elevation of Lower Tone Limit. A New Conception, Laryngoscope **38**:306 (May) 1928.

28. Sturm, F. Pearce: Adenoid Deafness, Ann. Otol. Rhin. & Laryng. **37**:79 (June) 1928.

in at least one third of all cases of acquired deafness in the adult has its origin from preventable causes during childhood or infancy. In an investigation of 200 cases, the incurable disabilities in 32 per cent resulted from nasopharyngeal disease during childhood. These figures do not include the resulting cases of active suppurative disease of the middle ear of any variety or degree. Adenoid deafness is purely mechanical in origin and is the most frequent variety of chronic progressive deafness met in practice, excluding otosclerosis, which is preventable in the light of present knowledge. It develops in three stages: that of occlusion, transudation and cicatrization, all of which are discussed thoroughly.

Fixation of the stapes is frequent in adenoid deafness, and its early detection is most important. The Gellé test is unreliable, particularly in children whose attention is distracted by the technic, rendering their responses valueless. A simpler test has been devised by Sturm. Four tuning forks are necessary: these are *C_1 32, C 64, c 128* and *c^2 512*. The tests depend on two well established otologic principles: (1) that when the labyrinth windows are occluded, the lower tone limit is raised in a degree proportionate to the loss of mobility in the windows and (2) that the amount of loss of mobility in the ossicular chain is indicated by the time relation of air conduction to bone conduction in the perception of tones of varying pitch.

A negative Rinne reaction, low in the scale, is found in a mild degree of loss of mobility in the chain of ossicles; a negative reaction, high in the scale, indicates a serious loss, and a negative reaction for all forks used is found in ankylosis of the stapes. A double negative Rinne reaction, that is for both *c 128* and the *c^2 512* forks, does not indicate fixation of the stapes if fixation means fibrous or bony ankylosis, for many patients who show this double negative Rinne reaction often lose it after operation or other treatment. In certain cases, in which treatment partially relieves the deafness, the Rinne reaction becomes positive for the fork of higher pitch, indicating some return of mobility of the stapes, the Rinne reaction for the lower fork still remaining negative.

In cases of progressive deafness where treatment has given no relief, the tuning fork triad of negative Rinne for c 128 negative Rinne for c^2 512, and absolute loss of hearing by air conduction for C 64 will be present, and is pathognomonic of ankylosis of the stapes in the oval window. This test has been used in many hundreds of cases, a number of whom have been kept under observation from childhood to adult life, and in no single instance where ankylosis of the stapes has been diagnosed by this method, is there any record of subsequent improvement of the hearing.

It has long been known that the lower the pitch of the fork used, the more likely is the Rinne reaction to be negative, and the higher the

pitch of the fork the more does the Rinne test tend to be positive. Therefore it is better to use a number of forks in doing the Rinne test, or to employ uniformly one of medium pitch, such as the *a 1* (435 double vibrations) which was recommended and used by Bezold. In the January, 1925, issue of the ARCHIVES OF OTOLARYNGOLOGY, I reviewed H. L. Wolff's paper (which appeared in *Ztschr. f. Hals-, Nasen- u. Ohrenh.*, 1923). He recommended the use of four octaves in doing the Rinne test, namely *C, c, c 1* and *c 2*, and he emphasized certain points in the evaluation of the test. Wolff postulates the following regarding the Rinne test: 1. In persons with normal hearing the Rinne reaction is positive for all tuning forks. 2. If the Rinne reaction is found to be positive for some one tone, it will never be negative for any higher tone. 3. If the Rinne test is decidedly negative for a certain tone, it will never be positive for a similar tone in the next higher octave.

I believe that Sturm's statements regarding the various types of stapes fixation (especially that said to be due to adenoids) are rather speculative in character.

A series of cases of chronic deafness was investigated from the standpoint of general physical condition and analysis of hearing.[29] Forty-four of these patients were found to be normal physically as compared with the average people at their age limits. The latest age at which the deafness can begin is at puberty as deduced from the patients' history and the duration of the disease. This probability is supported by the frequent association of a marked degree of dulness, apathy, poor speech and other factors which are probably due to an actual deafness, or to a low auditory acuity during school years. These patients did not have any difficulty in breathing through the nose. In these cases the condition has a specific etiology, beginning sometime during childhood; it is not due to local sepsis and is not connected with any disease, but may be associated with some constitutions or diathesis.

The analysis of hearing showed that deafness in this group was of the mixed type. A comparison of those cases in which the patients have an associated nasopharyngeal inflammation with those having none, revealed only a quantitative difference in the hearing. Those without nasopharyngeal inflammation revealed a high degree of deafness, a diminution in acuity of from 90 to 95 per cent. The authors stated that the Gellé and Walker tests are notoriously unreliable and difficult of interpretation, and that the results obtained in this series of cases hardly justified their inclusion.

I do not know what the "Walker" test is and do not see why the Gellé need be used in routine work. It is undependable and is of

29. Williamson, George Scott, and Richards, E. Horace: A Preliminary Study of Chronic Middle Ear Deafness, J. Laryng. & Otol. **42**:793 (Dec.) 1927.

actual value usually in testing the mobility of the stapedial footplate. Lately (as stated elsewhere in this review) Krainz has employed it for differentiating deafness of the round window and inner ear.

ENDOLYMPH PRESSURE

Kerekes [30] studied various neurologic conditions and cases of hypertension and hypotension. The author described affectio nervi acustici as that condition in which with diminished hearing there is a positive Rinne reaction with shortened bone conduction and lowering of the upper tone limit. The reason for conducting the tests was based largely on the observation that in some cases of involvement of the auditory nerve there was a relative improvement in the hearing after prolonged use of sodium nitrite.

Kerekes employed a number of measures in testing the auditory acuity, such as hearing for the whispered voice, hearing with various tuning forks (*C, c 1, c 4*), the Rinne and the Schwabach test. In connection with the latter, he lays emphasis on the care with which bone conduction must be tested in order to secure dependable results. I am heartily in accord with this view as expressed years ago and wish that more men took the same care that this author does.

The blood pressure was determined in a number of cases of hypertension. Then venisection was performed, with abstraction of from 200 to 400 cc. of blood; directly thereafter the blood pressure was again read, and the hearing was tested and compared with the result before blood-letting. The author found considerable improvement immediately following the lowering of the blood pressure, and assumed that this is due to a lowering of the endolabyrinthine pressure. In cases of normal pressure, lumbar puncture with reduction of the endolabyrinthine pressure showed a reduction in hearing. Apparently perfect hearing is dependent on a certain optimum pressure of the endolabyrinthine fluid. Kerekes mentioned the work of Rejtö with reference to the function of the round window and the symptoms resembling those of involvement of the auditory nerve noted in cases with interference of the proper mobility of the membrane of the round window, and seemed to be in accord with the latter's views.

The author stated the belief that the tonus of the endolabyrinthine fluid is a result of a combined action of intracranial pressure and the filling of the veins; the latter thus act as compensating factors since they can easily change their volume so that the optimum pressure may be sustained. The author's conclusions are that: 1. Reduction of hypertension favorably influences defective hearing in cases of involve-

30. Kerekes: Clinical and Experimental Investigation of the Relation Between Endolymph Pressure and Hearing, Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:458, 1927.

ment of the auditory nerve. 2. Increase of the intracranial pressure gives diminution with shortened bone conduction. 3. Reduction of the normal intracranial pressure also lessens the hearing. 4. The tests carried out show that for normal hearing a certain optimum of endolabyrinthine pressure is necessary.

The round window acts as a pressure release for movements of the labyrinthine fluid. With air conduction, it is the movements of the stapedial footplate which causes displacements of the fluid; with bone conduction there is not only the impulse from the stapes, but "also a rhythmic contraction of the bony labyrinth space pressing the fluid toward the round window, whose membrane is much more movable than is the oval window." [31] Since the degree of hearing is dependent on the freedom of movement of the labyrinthine fluid, and the latter is influenced by the mobility of the secondary auditory membrane, it follows that any interference with the proper freedom of the round window will cause a diminution in hearing directly proportional to such limitation of motion. Hearing by bone conduction is likewise reduced, and this shows not only that diminished bone conduction is a symptom of involvement of the inner ear, but that it may be due to interference with the proper function of the round window as pointed by Rejtö some years ago.

Impaired mobility of the membrane of the round window may be due to bony changes, for instance, otosclerosis, but may temporarily be due to inflammatory exudates. In the latter instance, the symptoms even though they resemble those of involvement of the inner ear, are relieved by catheterization. This form of auditory disturbance should, according to the author, be termed cochlear foramen hearing impairment. To test the function of the round window and to differentiate involvement thereof from impairment of hearing in the inner ear, the Gellé test is valuable. Its effect depends on compression of air in the tympanic cavity caused by tension or diminished mobility of the membrane of the round window with the resultant lessening of hearing. At the same time, the compression of the air in the external auditory meatus causes lateralization to the opposite ear of sounds that come through bone conduction. Thus one has produced apparently an artificial involvement of the inner ear, but that it is really due to interference of the round window is demonstrated by the fact that swallowing (with the accompanying opening of the eustachian tube) causes return of the lateralized sound to the ear under examination. The Gellé test thus produces its effect by action on the round window. "The whole test with positive Gellé and the act of swallowing shows normal function of the

31. Krainz, W.: The Functional Significance of the Round Window, Verhandl. d. Gesellsch. deutsch. Hals-, Nasen- u. Ohrenh. Aerzte, June, 1927; Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:433, 1927.

round window." A negative Gellé reaction and the failure of swallowing to change the lateralization show interference with the round window, provided always that the Rinne test and examination of the low tones show normal mobility of the ossicular chain.

Artificial impairment of hearing in the round window results from tension of or suction on the membrane not only with a Valsalva test, but during catheterization of the eustachian tube. Not only impairment but also actual improvement may, under certain conditions result via the round window, according to Krainz. In cases of large, dry perforations of the drum membrane, with more or less fixed ossicular chain, it is possible by plugging the niche of the window to depress the low tone limit and to improve the hearing for the whispered voice.

The author speculated on the modus operandi of this procedure somewhat as follows: The insertion of a pledget into the window niche puts the membrane on tension as evidenced by the resultant diminution in bone conduction; one would therefore likewise expect a reduction in hearing via air. The increased tension of the ossicular chain and the opening of the tympanic cavity, however, produce certain conditions which are of importance. The improved hearing may possibly be due to a change in the natural frequency of the secondary tympanic membrane (because of the loading and increased tension), so that it approaches that of the lower tones; thus an increased amplitude might arise which is transmitted to the labyrinthine fluid. On the other hand, it is possible that the improvement in hearing for whispered voice, especially the sounds of the letter "s" may be due to an increase in the "sound shadow" (Schallschatten) of the promontory by the plugging of the round window niche. An exact explanation for the phenomenon described has as yet not been found.

I would like to state that I do not understand what is meant by a narrowing of the "bony" labyrinthine canal mentioned by the author; is it possible that this is a typographical error and is intended to read "membranous" labyrinthine canals or space? This paper is a most interesting one particularly with reference to the theories of the functions of the round window, regarding which Rejtö wrote some years ago.

CRANIAL RESONANCE

Demetriades [32] has published a number of articles on cranial resonance and its variations in a number of conditions. I have reviewed these in various numbers of the ARCHIVES OF OTOLARYNGOLOGY, so that I shall not repeat details. The author's general conclusions are that

32. Demetriades, T. D.: Investigations of Cranial Resonance. Second Communication. The Character of Cranial Resonance in Brain Tumors and Its Relation to the Oral Findings, Ztschr. f. d. ges. Neurol. u. Psychiat. **107**:184, 1927.

better resonance is noted on the side of the tumor, and often the Weber is lateralized on the same side. At times with neoplasms in the posterior cranial fossa, there is also noted a spontaneous past-pointing of the hand toward the side of the tumor, and at times involvement of the contralteral cochlear nerve and a choked disk more marked on the side of the tumor. The author stated the belief that the origin of this symptom-complex is due to a greater filling of the blood vessels on the side where the tumor is situated.

The acuity of hearing was determined under several test conditions, such as having the mouth closed, mouth closed and the teeth clenched, the mouth wide open, mouth open to form an aperture and cavity, and an acoustic fan held between the teeth.[33] The sound was produced by a telephone receiver lying on a soft pad, 30 inches in front of the observer. The acuity under the different conditions was compared by varying the current through the receiver, and measuring the minimum current necessary for hearing the tone under each condition. "The acoustic fan is made of flexible hard rubber, fitted with a string which serves to pull the surface of the fan into a bowed or bent form, and maintain it in position. The fan is held by the handle, with the top of the fan bent toward the person and the upper edge held firmly between the teeth." Two subjects were tested. One who was able to hear normal conversation without any difficulty, but who had deficiency for air transmitted sound, requiring 300,000 times normal intensity to hear with both ears, and with practically a normal bone conduction, gave the following results: Clenching of the teeth was of advantage at the lower frequencies, but made no difference above 512 cycles; opening of the mouth was a slight aid to hearing at the lower frequencies; tuning the mouth cavity in resonance with the pitch presented was of considerable help in acuity for the frequencies of 768 cycles and lower; the fan held between the teeth increased the sensitivity from 356 to 1,024 cycles per second. The benefit derived, when compared with the condition of the closed mouth was high as a factor of 760 to 512 cycles per second. The other subject showed considerable deficiency for both air and bone conduction. He experienced considerable practical benefit in conversation through the use of the acoustic fan, even with a bone acuity so low that the quantitative measurements were not possible. No benefit was derived from opening the mouth or attempting to tune the mouth cavity to the pitch to be heard.

Sabine reported measurements on the acoustic fan in a person with only slight benefit at 256 and 512 cycles. He found that this person did not derive any benefit through the use of the fan for conversational

33. Pohlman, A. G., and Kranz, F. W.: Observations on Hearing Acuity for Bone-Transmitted Sound, Proc. Soc. Exper. Biol. & Med. **24**:456, 1927.

purposes. A diagnosis of stapedial fixation was made in this case. If this diagnosis was correct, then the acoustic fan may be employed as an aid to the diagnosis of stapedial fixation. These tests with an acoustic fan seem to indicate an available method for determining the acuity for bone transmitted speech.

In this preliminary paper Birkholz [34] presented the results of the examination of twenty-five subjects using the forks *A* (108 double vibrations) and *a 1* (435 double vibrations). In normal cases with few exceptions, the Weber is heard in the head; with the fork placed in the region of the parietal eminence crossed perception was seldom noted. With the fork at the rim of the nose the same results were observed as when it was set on the vertex, but in a few cases there was lateralization to one side or the other without definite reasons therefore. Placing the tuning fork at the upper part of the inner canthus of the eye, the author observed crossed perception in 50 per cent of the cases. In cases of infection of the middle ear the sound was lateralized to the diseased side, and crossed resonance could not be obtained from the inner canthi. With sinus disease, a definite lateralization to the diseased side was never noted. In a few cases there was a slight indication of such lateralization, but never was it so distinct as with disease of the middle ear.

The subject of crossed perception and resonance has been considerably dealt with in the literature, and as I pointed out in several papers, it is not a new subject. The matter was well known to many of the older otologists; it was then apparently allowed to lapse, and was again thoroughly discussed in 1925 by men like Schoen and Goldberger of Vienna, Claud of Berlin and others.

So far as the value of crossed perception for diagnostic purposes is concerned, it has been my opinion, as previously expressed, that there are so many fallacies connected with the lateralization of sound by bone conduction, that it is doubtful whether the new modification suggested in recent years by the men already mentioned has any advantage over the regular Weber, Schwabach and Rinne tests when carefully done—and when results are properly evaluated. So far as the lateralization of the Weber test is concerned, I emphasized in a paper on this subject many years ago that the sound may be referred to one or the other ear even when both are normal, or may in not a few instances be referred to the side not expected in pathologic cases. For example, with a decided involvement of the middle ear on the right side, the Weber test may, in a certain percentage of cases, be lateralized in the left ear.

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34. Birkholz: Crossed Perception of Tuning Fork Tones by Bone Conduction Under Physiological and Pathological Conditions (Preliminary communication), Folia Otolaryngol., I. T1; Ztschr. f. Laryngol., Rhinol. **15**:224. 1927.

I would therefore like to emphasize again the fact that the Weber test, while useful in some cases, is the least reliable of the major tuning fork tests, and that it is of value as a rule only when it agrees with and confirms the other tests.

OTOSCLEROSIS

A series of 1,015 cases was investigated.[35] The functional examination in these cases showed the following results:

The Schwabach test in 855 cases showed lengthened bone conduction in 767, normal in 41 and shortened in 47 cases.

The Weber test in 755 cases was lateralized to the worse ear in 390, not lateralized in 251 and lateralized to the better ear in 114 patients.

The Rinne test was performed in 966 cases, with a negative reaction in both ears in 648 cases; and a positive reaction in both ears in 69 cases. A positive reaction in one ear and a negative reaction in the other occurred in 249 cases.

Investigation of the low tones revealed the *C 1* (32 double vibrations) not heard in 884 cases; *C 1* (32 double vibrations) heard in 286 cases; c^4 not heard in 677 cases and heard in 460 cases. There was unilateral deafness in 248 ears and bilateral deafness in 755 cases.

The middle tones, namely: *c* (128), *c 1* (256) and *c 2* (512) were heard by 544 patients and not heard by air conduction in 202 cases.

The upper tone limit was investigated in 574 cases; 16,000 double vibrations were taken as the normal and tested with the monochord. Fifty-seven cases were normal, 300 cases had a lowered tone limit, and 217 were nearly normal.

The watch was heard by air conduction in 505 of the 718 cases tested. Of 802 patients whose hearing was tested by bone conduction, 527 heard it, but in 275 cases the patients were unable to hear the watch on the forehead or on either mastoid.

The whisper and the conversational voice were noted in 529 cases. The whisper was heard at 3 feet in 189 cases, at from 1 to 2 feet in 164 cases and at less than 1 foot in 176 cases.

The conversational voice was heard at less than 1 foot in 79 cases, at 1 foot in 74 cases, at 3 feet in 60 cases, at 4 feet in 22 cases, at from 5 to 10 feet in 38 and at over 10 feet in 16 cases.

DETECTION OF SIMULATION

Becker[36] employed the cup of the Bowles stethoscope or any similarly constructed instrument to which is attached a piece of soft

35. Leeson, L. A.: The Chemical Aspect of Otosclerosis, J. Laryng. & Otol. **2**:89 (Feb.) 1928.

36. Becker, B. M.: A Novel and Simple Method for the Detection of Simulation of Unilateral Deafness, Laryngoscope **38**:677 (Oct.) 1928.

rubber tubing 12 inches in length. At the distal end of the tube is inserted a metal or hard rubber bifurcated piece, and at each end thereof a soft rubber tube, one being 12 inches and the other 24 inches in length, fitted with proper sized ear pieces. The method consists of first ascertaining that the patient hears distinctly the ticking of any of the instruments employed through the longer tube when it is inserted in his normal ear, and the diaphragm of the stethoscope is placed directly on the surface of the ticker or in its immediate vicinity.

Care must be exercised in the choice of the sound producing mechanism; if it is too loud the sound may be heard outside the tube and thus vitiate the test. If it is not loud enough, it will necessitate the shortening of the tubes, making it inconvenient by working too close to the patient's ear.

The test depends upon two facts, the first of which is the principle that when tubes of unequal length are used when listening to anything through them, the sound will always be lateralized to the side of the shorter tube. The sound through the longer tube is completely masked so that we are aware of monaural hearing, whereas the hearing is actually binaural. The second element in the test depends upon the factor of binaural hearing. When one pinches or compresses the longer tube from which apparently no sound reaches the ear one immediately becomes aware of a decided change in the sound in the opposite ear, due no doubt to the fact that binaural hearing has been converted into monaural hearing.

If I am not much mistaken, the principles involved in this test, although there is a difference in the size and length of tubes employed, is the same as that originally suggested by Dr. Callahan of Brockton, Mass., some years ago. The idea of the test is good, but I do not believe that it is more dependable than a properly performed Stenger test.

Guttman [37] quoted Bezhold to the effect that "when a normal ear was properly occluded and a 480 tuning fork (I believe that he means *a 1* [435 double vibrations] fork) was placed in front of the other ear, the labyrinth of which had been previously extirpated, the patient could still hear the tuning fork. His explanation of this phenomenon was that the sound of the tuning forks had been conducted to the normal labyrinth by bone conduction.

Guttman's method is founded on the following physiologic facts: "If two tones of identical frequency and sufficiently great difference of intensity (5 sensation units) are introduced simultaneously one in each ear, only the tone of the greater intensity will be heard and will be lateralized in that ear." He states that:

Deafness by my method is determined in the following way: The normal ear is not occluded but on the contrary a tone is introduced into that ear by placing a telephone receiver which is connected with my audiometer and a tone is established. Then through a second receiver similarly connected, a tone of the same frequency

37. Guttman, John: A New Method of Determining Unilateral Deafness and Malingering, Laryngoscope **38**:686 (Oct.) 1928.

is introduced into the deafened ear and the intensity increased until the tone in the normal ear is suppressed and the lateralization of the tone in that ear is abolished. This forms the threshold in the deafened ear. The detection of simulation rests upon the same reason.

Guttman has long done work with audiometers; in fact, I believe he was one of the first in America who devised an apparatus employing the vacuum tube oscillator. This test, like a number of others employed for the detection of simulation of unilateral deafness, depends on the fact that with two sources of sounds of equal pitch and intensity placed at equal distances from two normal ears, the sound will be the same in both ears, but when one source of sound is approached nearer to one ear, the intensity will be so great that it will mask the sound coming into the opposite ear. On this fact, as previously stated, rests the principle of the Stenger test.

Hinsberg[38] stated the belief that the Stenger test is one of the most valuable ones used in the determination of unilateral simulated deafness. He pointed out that there are two disadvantages of the test: (1) that it is difficult to strike two tuning forks exactly alike, and that they die down quickly, and (2) that it is desirable that the patient sing the tone that he is supposed to hear, in order to have a control, but with nonmusical subjects, it is difficult to do this. The first objection that the forks die down so quickly, and cannot be equally excited or struck with the same intensity may be overcome by the use of an electrically driven fork. From the use of the head pieces for radio, the author conceived the idea of an apparatus in which the telephone service may be employed. The patient's eyes are covered, with opaque spectacles, so that he is unable to observe the procedure that is being carried out. The apparatus is placed behind the patient—a horizontal bar attached to a perpendicular one and the latter resting on the floor; two hard rubber disks which may be applied against one or the other ear and two telephone receivers also attached to the horizontal bar may be brought to any desirable distance from one or the other ear. With sounds such as the voice or whistles transmitted to this telephone circuit, the Stenger test is carried out along the same line as is usually done with a pair of tuning forks of the same pitch struck with the same intensity. The whistles usually employed are those that come with the Edelman tuning fork set.

I have always felt that the Stenger test is an excellent one for unmasking simulated unilateral deafness. It seems strange (and I believe I have called attention to this fact before on a number of occasions) that so few textbooks and articles on functional testing

38. Hinsberg, V. Breslau: A Modification of the Stenger Test, Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:259 (May) 1928. This is a Festschrift for Otto Kerner.

of hearing mention this valuable test. It is true, as Hinsberg has stated, that it is a little difficult to strike both forks with equal intensity and secure long duration of vibration unless good forks such as the type suggested by Bezold and made by Edelmann (namely, the *a 1* (435 double vibrations) or similar ones are used. The principle on which the test is based is that when two sources of sound of the same intensity and pitch are brought to both ears, if one is nearer to one ear it will drown out the sound entering the opposite ear from which the source of the sound is farther removed. If the subject tested is actually deaf on one side, no matter how close the source of sound is brought to that ear, he will not hear it, but will hear a sound approaching the opposite ear.

So far as Hinsberg's apparatus is concerned, it seems to be an excellent idea, but it requires a little more apparatus than would be advisable in an otologist's office. In most countries in which recruiting is compulsory many cases of simulation occur, but in private practice, in this country at least, it is rather unusual to find them, most of the cases being of personal injury with contemplated suit for damage. I believe therefore that the Stenger test, if done in the usual manner with a pair of first class forks of medium pitch as previously described, will give satisfactory results without complicated mechanisms.

180 North Michigan Avenue, Chicago.

GREENFIELD SLUDER, M.D.
1865-1928

Obituary

GREENFIELD SLUDER, M.D.
1865-1928

Dr. Greenfield Sluder, clinical professor of laryngology in Washington University School of Medicine, and a member of the editorial board of the ARCHIVES, died Oct. 9, 1928, of pneumonia, after a long illness.

Dr. Sluder was born in St. Louis in 1865 and was graduated from the St. Louis Medical College (now the Medical Department of Washington University) in 1888. His early training included a four years' surgical residence in St. Louis City Hospital and six years' association in general medicine with Dr. W. E. Fischel, the distinguished internist.

Beside his training in laryngology abroad, his work there was largely concerned with physiology and anatomy, and all his later studies showed a great appreciation of these underlying basic sciences. His earliest papers were concerned with headaches and diseases of the accessory sinuses, and to the treatment of these diseases he devoted his life. As early as 1900, he published, jointly with Dr. A. E. Ewing, a work on the nasal conditions found in frontal headaches "with special reference to an abnormal relation of the uncinate process to the bulla of the ethmoid." His first significant contribution on the neurology of the nose was published in the *New York Medical Journal*, May, 1908, and was entitled "The Rôle of the Sphenopalatine Ganglion in Nasal Headaches." This was followed by a long list of contributions on allied subjects.

The tonsil operation which bore his name was introduced to the Missouri State Medical Association in March, 1912, and to the American Academy of Ophthalmology and Otolaryngology in August of that year.

Dr. Sluder was a prolific writer. His contributions to the literature number almost 100, including three monographs, "Headaches and Eye Disorders of Nasal Origin" (1919), "Tonsillectomy" (1923) and "Nasal Neurology, Headaches and Eye Disorders" (1927).

He devoted a large part of his time to teaching, and his sympathetic attitude toward his students and teaching associates earned for him their undying affection.

A. W. P.

Abstracts from Current Literature

Ear

ETIOLOGY OF AN EPIDEMIC OF ENTERITIS, ASSOCIATED WITH MASTOIDITIS, IN INFANTS. GEORGE F. DICK, GLADYS HENRY DICK and J. L. WILLIAMS, Am. J. Dis. Child. **35**:955 (June) 1928.

The authors report an epidemic characterized by diarrhea, loss of weight, regurgitation, fever, otitis media and mastoiditis, in an institution for infants. There were twenty-seven fatal cases. The tympanic membranes were incised in eleven cases and mastoidectomy done in five; surgery had no apparent effect on the course of the disease. All five patients on whom mastoidectomy had been performed died. In the early stages of the disease the intestinal manifestations were more marked and the mastoid lesions less advanced than in those who survived the first week or two of illness. Later, the enteritis subsided and the mastoiditis became marked.

Bacteriologic studies showed that there was an invasion of the blood stream by the organisms found in the pus from the mastoid, these being mainly colon bacilli and green-producing streptococci. In order to determine whether the disease was primarily an infection of the upper respiratory tract, with a secondary otitis media and mastoiditis, or a primary infection of the alimentary tract, resulting in a septicemia and secondary mastoiditis, nose and throat cultures were made of all sick and well patients in the institution. The two groups showed the same bacteriology. Green-producing streptococci predominated in throat cultures, staphylococci and pseudodiphtheria bacilli being present only occasionally.

The green-producing streptococci found in the mastoid post mortem were similar to those found in the throat cultures of both the sick and the well infants. These organisms are normally present in infants; this observation, therefore, did not mean that these organisms were the primary cause of the epidemic.

The fact that colon bacilli were found in mastoid cultures at operation indicated that their presence was not merely a terminal affair but that the intestinal infection was possibly the primary factor. At subsequent autopsies additional studies revealed a Morgan dysentery bacillus, *Proteus asiaticus* and *Eberthella pyogenes*. The Morgan dysentery bacillus was highly pathogenic.

These observations indicated that the epidemic was not due to an air-borne infection, but was of intestinal origin. Measures were taken to insure the sterility of all food, comprising the autoclaving of bottles and nipples, and the wearing of sterile rubber gloves by nurses for all feedings and giving of water. The epidemic promptly subsided after the adoption of these measures.

The authors believe that this was an epidemic of enteritis, associated with mastoiditis, and caused by a primary intestinal infection in which the Morgan dysentery bacillus was found. The epidemic was promptly controlled by the sterilization of all feedings.

CONNOR, St. Paul.

CERTAIN ASPECTS OF TINNITUS, PARTICULARLY ITS TREATMENT. JONES and KNUDSEN, Laryngoscope **38**:597, 1928.

One of the most perplexing problems of otology is that of tinnitus aurium. The many theories and forms of treatment of tinnitus are indications that it still belongs to the realm of speculation. Owing to the difficulty of approach, only a meager amount of experimental work has been done on the subject. The authors believe that such investigative work should begin with the production and study of tinnitus under experimental control, as well as with measurements

of the precise pitch and loudness of a tonal tinnitus and the determination of the more complicated character of the tinnitus that is not tonal.

"Noises in the head" constitute one of the most distressing and persistent symptoms that can disturb a patient, whether he is merely annoyed by a slight noise or distracted by continuous intense noises from which he cannot escape. Tinnitus is a disturbance of the auditory mechanism, affecting especially the cerebral auditory centers, without which there cannot be tinnitus, although the source may also, in part, be along the auditory pathways or in the auditory end-organs. Severing of the eighth nerve or destruction of the cochlea have, in some cases, failed to relieve tinnitus, which suggests that the repeated or continous insults to the auditory centers have brought about permanent changes in these centers in the form of what one might call "memory pictures." There is little evidence of tinnitus being produced by lesions along the auditory intracranial pathways, but lesions of the eighth nerve may produce it. In the great majority of cases, the exciting cause apparently lies within the end-organ itself, including the cochlea and the conducting mechanism of the middle and the external ear. It would seem that the nervous mechanism of the end-organ can be disturbed in only two ways: first, by actual irritation or stimulation of the cochlear structures themselves; second, by the introduction into the cochlea of vibrations set up in the conducting mechanism of the middle ear. A lesion in the cochlea manifests itself in an impairment of hearing or in tinnitus or in both. To produce both, the lesion must possess two sets of characteristics. The characteristic required for the production of tinnitus is that of excitation of the nerve fibers; the characteristic required for the impairment of hearing is that of an absence of normal excitation of the nerve fibers. Thus, an impairment of hearing would be considered due to an insufficient stimulation of the nerve, and tinnitus to an abnormal stimulation of the nerve.

As regards tinnitus excited by lesions of the conductive apparatus, it is evident that these must, in some way, affect the cochlea. A lesion within the middle ear could not of itself produce an irritation of the auditory endings; it apparently causes the introduction of vibrations into the cochlea. These vibrations may be brought about by the alternating contraction of the muscles of the middle ear. The theory of Lathrop is cited by the authors. Various lesions of the middle or the external ear may cause the displacement of the ossicular chain, thus destroying the normal balance existing between the ossicular chain and the two middle ear muscles. In this way, either the tensor tympani muscle or the stapedius muscle or both are in a state of tension. The tensed contractions of these muscles in attempting to restore the ossicles to their normal position may set up vibrations which are transmitted to the cochlea, resulting in tinnitus.

Tinnitus is not always a necessary accompaniment of an impairment of hearing. In an analysis of 340 cases exhibiting various degrees of impairment of hearing, tinnitus was complained of in 201, or 59 per cent. Of these 201 cases of tinnitus, 70 were associated with lesions of the conductive apparatus, 54 with lesions of the perceptive system and 77 with lesions of both the conductive and the perceptive mechanisms.

The treatment may be classified into local and general and mechanical. Local treatment is limited to conditions of the external and the middle ear, such as removal of obstructions from the external ear, improvement of the condition of the middle ear by various standard operative procedures in the nose and the throat, when indicated, and local treatment of the eustachian tube and the middle ear. In severe cases, the eighth nerve has been severed, but the results following this procedure have not been altogether satisfactory. All focal infections must be removed, since these are frequently the cause of cochlear irritation. Syphilis must be eliminated as a possible cause. Various drugs, alcohol or tobacco may be a factor. In cases of hyperthyroidism, proper medical treatment will relieve the tinnitus that occasionally accompanies this condition. When it accompanies hypothyroidism, thyroid extract may be used with good results. Tinnitus observed during the menopause may be relieved by ovarian extract. The blood pressure

should be investigated. In the line of mechanical treatment, the authors have constructed two types of instruments for the relief of tinnitus, one for the "bombardment" of the cochlea, and the other for the purpose of masking the tinnitus. The former was suggested by animal experiments, its object being to desensitize the cochlea in certain tonal regions — the regions corresponding to the tinnitus. The second type of instrument for the temporary masking of tones or noises, includes two different instruments, the construction of each of which is explained in detail by the authors. Such instruments do not "cure" the tinnitus, but, as suitable experience has proved, they provide relief for those who are unable to sleep because of tinnitus. A patient is not distressed by a sound that is produced outside of himself.

A Novel and Simple Method for the Detection of Simulation of Unilateral Deafness. Becker, Laryngoscope **38**:677, 1928.

The test as described by the author depends on two facts, either of which can be used for testing purposes. The first is that when tubes of unequal length are used to convey a sound into the ears, the sound will always be lateralized on the side of the shorter tube. The sound through the longer tube is completely masked, so that one is aware of monaural hearing, whereas the hearing is actually binaural. The second is the fact that when the longer tube is compressed, one immediately becomes aware of a decided change in the sound in the opposite ear, due to the fact that binaural hearing has been converted into monaural hearing.

The mechanism used is a Bowles stethoscope, to the shallow cup of which a piece of soft rubber tubing, 12 inches (30.48 cm.) long, is attached. In the distal end of the tube the metal bifurcated piece is inserted, and to the ends of this are attached soft rubber tubes, one 12 inches (30.48 cm.) and the other 24 inches (60.96 cm.) in length, each fitted with ear pieces of proper size. The first step is to ascertain that the patient hears distinctly some ticking instrument through the longer tube, when it is inserted in his normal ear. The examiner then stands behind the patient and compresses and releases the two tubes at various and irregular intervals, asking the patient to tell him when a change in sound is noticed. If the longer tube is in the supposedly deaf ear, compression of it should not cause any change in sound through the shorter tube. The order of the tubes may later be reversed, the shorter one going to the supposedly deaf ear. The same questions are asked and, if the patient is malingering, it is impossible for him to avoid being exposed at some time during the examination.

A New Method of Determining Unilateral Deafness and Malingering. Guttman, Laryngoscope **38**:686, 1928.

The usual methods of determining deafness of one ear by the use of speech, tuning fork or even audiometer do not succeed easily because the exclusion of the normal ear from hearing is difficult. The most common method of exclusion is to place a wetted finger or a Bárány noise apparatus in the ear canal of the normal ear; but neither is entirely satisfactory, the main disadvantage being that it deafens not only the normal ear, but also, to some extent, the diseased ear.

The author's method is founded on the physiologic fact that during the perception of one sensation a second sensation can be perceived contemporaneously only when the second sensation differs within certain limits from the first sensation quantitatively or qualitatively or in both respects. The minimal difference required for the contemporaneous perception of two sensations is called the differential threshold. When two tones of identical frequency and sufficiently great difference of intensity are introduced simultaneously, one in each ear, only the tone of the greater intensity will be heard, and it will be lateralized in that ear. In determining unilateral deafness, the author does not occlude the normal ear, but, on the contrary, introduces a tone into that ear by placing to the ear a telephone receiver connected with an audiometer and establishes the differential threshold. Then,

through a second receiver similarly connected, a tone of the same frequency is introduced into the deafened ear and its intensity increased until the tone in the normal ear is suppressed and the lateralization of the tone in that ear abolished. By this means, the threshold in the deafened ear is determined. The detection of simulated deafness is carried out in the same way.

SNAPP, Grand Rapids, Mich.

OTITIS AFTER PACKING OF THE NOSE AND NASOPHARYNX. BACTERIOLOGY AND CLINIC. TIBOR GERMÁN, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:191 (Sept. 5) 1928.

The following measures in the nose and nasopharynx may cause acute inflammations of the middle ear: (1) improper irrigation and blowing of the nose; (2) cauterization of the nose; (3) operations in the nasopharynx—especially adenotomies, which may cause an injury to the tubal ostium or an inflammation of the wound; (4) packing of the nose and of the nasopharynx (after Bellocque) on account of hemorrhage, or prophylactically during operations. Not only mechanical pressure of the soft parts of the tubal ostium but also abnormal secretion, with decomposition of the secretion, are concerned, especially when the packing is left in situ for a long time (Stenger). In the outpatient department of the largest ear clinic in Budapest, only twenty-eight cases were observed from 1919 to 1928. Hartmann reported three cases in 1881. Some authors report the appearance fourteen hours after introduction of the packing (retronasally), whereas Goldberger reported the occurrence on the fifth day after removal of the packing. Most authors (Finder and others) permit the packing to be left in place for only twenty-four hours. In many instances, in spite of all precautions, a complication in the ear may set in. Otto Mayer claims that such a complication is more or less present in every case. He has observed a slight hyperemia of the drum membrane in every case. In such instances, the immediate removal of the packing prevents the development of an otitis. If swelling of the drum membrane accompanies the injection, the removal of the packing is imperative, in Mayer's opinion. The anterior packing of the nose may cause trouble by way of the lymph vessels (von Lenart, Most). The occurrence of tonsilitis is easily explained by the paths of the lymph vessels. The author reports twenty-eight cases in great detail. Retronasal packing was done in six instances. In one patient, a spontaneous perforation of both drum membranes occurred during the first twenty-four hours. If one side of the nose was packed (six cases), the ear on the same side became diseased. In half the cases of retronasal packing, unilateral, in the other half, bilateral otitis occurred. Of the twenty-eight patients, twenty-three were cured without an operation. The bacteriologic observations were as follows:

Organism	No. Cases
Streptococcus hemolyticus	8
Pneumococcus	3
Streptococcus (Pneumococcus) mucosus	2
Streptococcus viridans	1
Gram-negative *Diplococcus*	1
Streptococcus hemolyticus and *Pneumococcus*	9
Streptococcus hemolyticus, Bacillus pseudodiphtheriae	1
Pneumococcus and *Staphylococcus pyogenes*	1
Pneumococcus and *Micrococcus tetragenus*	1
Pneumococcus and gram-negative *Diplococcus*	1
Strephylococcus pyogenes aureus, Bacillus Pseudodiphtheriae and *Diplococcus*	1
	29

In a bilateral infection, pus in the right ear contained *Streptococcus hemolyticus* and *Streptococcus pseudodiphthericus,* whereas on the left side *Pneumococcus* was present. The microbes found in otitis following packing are also normally in the throat, the tube and the nose, especially in the nose and in the throat of patients with hypertrophies, deformed septums, accessory sinus diseases, adenoids, etc. In

order to become pathogenic, these microbes must become more virulent. This increase in virulence is greatly favored by packing, especially if it is left in place for a long time, and, most frequently, if it is repeated (Marshik), whereby more favorable conditions are created for the microbes. Clinical symptoms in the form of local inflammatory conditions and, perhaps, rise in temperature bear out this statement. Caldera and Santi proved the injurious influence of packing in experiments on animals, especially when gauze which was not antiseptic was used. This effect was especially evident in an increase of the virulence of old microbes. New microbes could be observed only after packing with sterile gauze. The relative benignity of the otitis caused by packing may be explained by the circumstance that the system can more easily deal with effects of its own microbes, on account of a certain degree of immunity, even if they show increased virulence. In this manner, also, the surprising benignity of the polymicrobic infections may be explained.

AMBERG, Detroit.

Pharynx

AGRANULOCYTIC ANGINA. HUEPER and O'CONNOR, Laryngoscope **38**:679, 1928.

In reviewing the literature on this disease, the authors conclude that it is not frequently seen in this country, the number of reports published in American literature representing only about 15 per cent of the total number of cases, or about 125. By far the majority are recorded in Germany and Austria, but the disease is apparently spreading in this country, 50 per cent of the American cases having been reported in 1927. The authors report five additional cases, all of which terminated fatally. The symptoms were almost the same in all cases, beginning with a sudden attack of sore throat, high fever, headache, extreme weakness, chills and pain in the back and limbs. In all cases the disease was highly toxic from the beginning and in some there were marked dyspnea, loss of voice, frequent coughs and inability to swallow. Fetid mucoid material was often expectorated, and the breath was foul, often presenting an odor of dead flesh. In the throats were large ulcerated areas involving the tonsils and the soft palate, and sometimes extending over the base of the tongue. The temperature varied between 101 and 105 F. Smears from the throat revealed many fusiform bacilli and spirilli, short chains of streptococci, staphylococci and encapsulated pneumococci. Blood cultures rendered hemolytic streptococci in some cases. One of the important characteristics of the disease was the blood picture, which revealed a marked decrease in the number of leukocytes. This was often extremely rapid, as illustrated in the first case of the authors' series. On the day preceding death, the leukocyte count was 1,100 and on the day of death three counts were, respectively, 600, 200 and 100. In the other cases, the count varied from 3,400 down to 150, always decreasing rapidly before death. There was also a marked reduction in the percentage of the neutrophil leukocytes. The investigations made in this series of cases did not give the authors any positive information regarding the causes, but they concluded that the unknown toxic element active in this disease injures not only the granulocytic system but also the lymphatic one, as is evident from the marked absolute decrease of the number of lymphocytes in the blood and the atrophy of the lymphatic tissue in the spleen and the lymph nodes.

SNAPP, Grand Rapids, Mich.

Nose

VINCENT'S INFECTION OF THE NOSE: REPORT OF A CASE. HAROLD I. SHULMAN, Am. J. Dis. Child. **36**:352 (Aug.) 1928.

Shulman reports the case of an Italian boy, aged 3 years, with a sanguineous nasal discharge, cervical adenitis, temperature, a greenish yellow membrane on the mucous surface of the upper lip and congested bleeding gums. Direct smears from the nose showed great numbers of fusiform bacilli and spirilla. Diphtheria cultures were negative.

Treatment consisted in swabbing the nose with half strength hydrogen peroxide, followed by the application of 5 per cent chromic acid twice a day. Later, nasal irrigations of sodium perborate were used, together with a mouth wash of potassium permanganate 1:5,000. Bromides were given for restlessness. The condition responded well to this treatment, the smears for Vincent's becoming negative on the fifth day. The nasal discharge stopped on the twelfth day.

The author points out that, while Vincent's infection of the oral membranes is well known, that of the nose is rare and may be overlooked owing to the frequency with which sanguineous nasal discharge is due to either diphtheria or foreign body. Vincent's infection may exist with diphtheria.

In any persistent, sanguineous discharge Vincent's infection should be considered and its presence or absence established by direct smears. CONNOR, St. Paul.

CONGENITAL DEFECTS OF THE VOMER AND THE DEVELOPMENT OF DEFORMITIES OF THE SEPTUM. KARL M. MENZEL, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:181 (Sept. 5) 1928.

According to Gruenwald, a hypoplasia of the sphenoidal part of the septum accompanies a defect of the palate, but it can also occur by itself. Congenital defects of the vomer are reported in the literature. In addition, the defects of the quadrangular cartilage are constituted so that the cartilage, as well as the mucous membrane, is missing, and holes of various size can be seen. The opening sometimes is permeable only for a fine probe (Hansemann), but the whole cartilage may be missing. The author describes a case in point in which only the osseous vomer was completely absent, whereas the whole mucous membrane was intact. Gruenwald states that arrested development occurs: (1) by virtue of faulty involution of temporary forms; (2) through lack of normal occlusion; (3) through persistence of early steps of development, and (4) through lack of formative material. The author summarizes that in his case a complete congenital aplasia of the osseous vomer existed and a pronounced vertical deviation of the lamina perpendicularis and of the lamina quadrangularis toward the left side. Furthermore, a completely developed crista lateralis presented itself along a line which otherwise corresponds with the connection between the crista palatina, the lamina quadrangularis and the lamina perpendicularis with the vomer. As the lamina perpendicularis could develop freely downward, it must be assumed that in this instance, the deviation, and especially the crista lateralis, were not caused by external factors influencing their growth but by the embryonic lay which brought about the deviation of the septum and the overgrowth of the lower border of the lamina perpendicularis in the form of a crista lateralis. The case reported permits the conclusion that a number of septums are arranged in the embryonic lay not in the vertical plane. The deviated septum, with its sharp elevations, is surely of embryonic origin in a number of instances.

EXOSTOSIS FORMATIONS IN THE NASAL ACCESSORY CAVITIES AND THE MASTOID PROCESS. GEORG CLAUS, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:223 (Sept. 5) 1928.

One year previously, the author demonstrated by a roentgenogram the formation of exostoses in the nasal accessory cavities in a patient who was not operated on. Now the author had demonstrated an exostosis on the floor of the frontal sinus by roentgenogram in a patient who submitted to an operation on account of a swollen upper lid and fluctuation. The exostosis was removed. It obstructed the duct almost completely, so that the pus perforated the thin floor of the orbit laterally from the exostosis. The author has observed a number of patients with exostosis of the frontal sinus which did not cause any trouble and did not require removal. Exostoses occur also in the pneumatic spaces of the mastoid process. The author reports a case in point. The roentgen-ray observations were confirmed by the operation. The exostosis was found in an angle cell of the left mastoid process directly under the cortex.

AMBERG, Detroit.

Miscellaneous

TREATMENT OF FUSOSPIRILLARY INFECTION OF THE MOUTH IN CHILDREN. HAROLD S. BAKER, Am. J. Dis. Child. **36**:463 (Sept.) 1928.

Many remedies have been recommended for the local treatment of fusospirillary infections of the mouth, such as ulcerative gingivitis and tonsillitis, and their good effect may be due in part to the result of local cleanliness and stimulation. The majority of such cases yield to local treatment after a variable length of time, but a certain number resist therapy indefinitely and one cannot say in advance what the response is going to be. Occasionally, the disease advances to a point where life itself is threatened. Local treatment is extremely difficult in small children.

The author recommends intramuscular injections of sulpharsphenamine in full dosage as calculated for syphilis, approximately 15 mg. per kilogram of body weight. He finds no serious objection to such administration, provided the course of the disease can be well followed thereafter.

The results have been reasonably uniform and satisfactory, marked visible improvement occurring anywhere from one to four days. Complete healing of the gums requires considerably longer in most cases but there was no failure in the reported series.

The author points out that there is often a so-called latent period of from one to four days after the administration of the drug during which the lesions may not visibly improve; however, during this time restitution proceeds.

The author concludes that the intramuscular injection of sulpharsphenamine is efficacious for such lesions and is desirable for small children on account of the easy administration.

CONNOR, St. Paul.

THE CLINICAL PICTURE IN MYXEDEMA, ESPECIALLY OF THE EAR, NOSE AND THROAT, BASED ON SIX CASES. MANN, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:145 (Sept. 5) 1928.

Patients with a pronounced goiter want to be told by the laryngologist whether they should submit to surgical or medical treatment. A decision is arrived at by virtue of the general condition and the degree of stenosis. In exophthalmic goiter the doctrine of endocrinology is important for judgment. Internal medicine, neurology and surgery must help out. Myxedema is a hypothyreosis or an athyreosis, and perhaps not so rare as is generally assumed. Zondek formulated the syndrome of myxedema as inertia, slowing down of all physical and mental functions and decrease of the excitability of the vegetative nervous system. Six cases are reported.

CASE 1.—Colonel X, aged 51, seen Dec. 27, 1920, complained of difficulty in speaking; slips of the tongue occurred frequently. The senses of hearing and smelling were impaired. At night, he had dyspnea. His snoring awakened the family. The nose was thick and ungainly and the eyelids were puffy. The hands had become broader and thicker. He felt that he was clumsy. His fingers tingled. There was loss of sensibility. He could not button and unbutton his collar. Walking became difficult and he often staggered. The faculty to perspire had disappeared, and the patient felt cold continuously; the skin was entirely dry. Itching was pronounced. The patient suffered greatly from constipation; he felt tired; his memory was weak, and he became apathetic. He fell asleep easily, especially while sitting up. The libido had disappeared.

Status.—The face was puffy and without expression; the arms and hands were thick, and the skin over the chest was thickened. Puffiness was noted in the supraclavicular fossae. The skin was dry and scaling; the nose was narrow and the sense of smell decreased, especially on the left side. Hardness of hearing, of the character of inner ear deafness, was present on the left side. Speech was slow, gruff and dragging, similar to that of paralytic patients; the mucous membranes

of the throat and larynx were pale. Edema was not present in this region. Treatment consisted of the administration of thyreoidin 0.1 Merck three times a day. Two weeks later, the patient felt suprisingly better. The edema had almost entirely disappeared, and the speech was easier and more free. Memory and sleep had improved, and dyspnea and snoring were not noted. The senses of hearing and smelling had improved. Itching was absent. Past-pointing to the left had vanished. The gait had become sure. Later difficulties appeared at times, and relapses occurred. Irregularities of the pulse rate and palpitation of the heart set in. Slight albuminuria was present. The patient once took another preparation of thyroid, but he noticed the mistake. Later, he knew his normal doses and reported favorably.

CASE 2.—A man, aged 60, suffered from symptoms somewhat similar to those of the patient in case 1, and also from painful swelling of the nailbeds. A positive Wassermann reaction led to antisyphilitic treatment with mercury and neoarsphenamine, causing a rapid aggravation of the symptoms. Among other symptoms were pronounced apathy, absolute loss of pupillary reflexes, difficulty in eliciting the patellar reflexes and an intimation of a positive Romberg reaction. The thyroid gland could not be felt. Therapy with a preparation of thyroid led to rapid improvement. The dermatologist, Professor Werther, found myxedema, scleroderma, prurigo and hyperpigmentation, that is, insufficiency of the thyroid, hypophysis and suprarenals. The improvement bordering on a cure through a preparation of thyroid proves that hypothyreosis or athyreosis was the main underlying cause of the trouble. The syphilitic etiology is clear.

CASE 3.—A woman, aged 38, became syphilitic eighteen years before examination. After headaches and falling out of the hair had been noticed for a year, a painful swelling developed under both sternocleidomastoid muscles, undoubtedly of the nature of gummas. One year later, myxedema developed, possibly of a syphilitic nature. Treatment with arsphenamine and bismuth led to a sclerosis of the thyroid gland and to a hypothyreosis or athyreosis.

CASE 4.—A woman, aged 25 (*Ztschr. f. Hals-, Nasen- u. Ohrenh.* **21**:369, 1928), responded to treatment with a preparation of thyroid so that she could follow her occupation again.

CASE 5.—A woman, aged 55, had suffered twenty years previously from a slight exophthalmic goiter. She had violent attacks of coughing with a feeling of suffocation, palpitation of the heart, a feeling of fear and a pulse rate of 160. She lost from 2 to 3 pounds (1 to 1.5 Kg.) weekly as a result of diarrhea. On May 9, 1913, the goiter was operated on. From 1915 until 1918, she conducted the business of her husband. Sickness of her son brought about a relapse. Her cheeks and hands became thick. Whereas formerly she always felt hot, she now felt cold. The patient became hoarse. The family physician thought that she suffered again from exophthalmic goiter, but the author did not agree with him.

CASE 6.—A man, aged 36, responded to treatment with a preparation of thyroid for one week. Then the goiter on the right side required an operation. Subsequent treatment with the preparation of thyroid brought about improvement in his condition. The patient procured a prescription for a preparation of thyroid from another physician and took 300 tablets within a year. This resulted in a new outbreak, causing hyperthyreosis.

The author reviewed the symptoms of the ear, nose and throat in his cases.

A RARE CASE OF FOREIGN BODY IN THE BRONCHUS. CAESAR HIRSCH, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:156 (Sept. 5) 1928.

An electrician, aged 23, talked with his employer while holding staples in his mouth, and a staple entered a bronchus during a strong inspiration. Three and a half months later, the patient consulted the author. The staple was found by bronchoscopy at a distance of 33 cm. from the upper teeth, in the lower part of the left bronchus, with the arch downward. Efforts to remove the foreign body with von Eicken's forceps proved unsuccessful on account of the strong caliber.

Two attempts were made on different days. The second time, the granulations surrounding the staple were severed. Two days later, the author traveled with the patient from Stuttgart to Berlin to the clinic of von Eiken. The foreign body could not be detected; only the inflamed bronchial wall with some granulations was seen. Also, the examination of the stool gave negative results. In all probability, the foreign body had been loosened by the manipulations during the second bronchoscopic manipulations and the removal of the granulations. Later, the patient must have coughed up the foreign body, perhaps while sleeping.

LEPTOTHRICOSIS OF THE ORAL CAVITY. E. BRACK, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:174 (Sept. 5) 1928.

Leptothrix appears in the oral cavity most frequently as *leptothrix buccalis* (Leeuwenhoek). It is found as sordes on the teeth, especially in carious teeth. It is aggressive and is concomitant with formation of tartar and decalcification of the teeth. Leyden and Jaffe, and Lenhartz have found it occasionally in deeper processes, for instance, in tonsillar abscesses and in gangrene of the lung. Yet *leptothrix* could not be established as the causative factor of these diseases, contrary to the views of others. It is said to be found in the vagina as a harmless parasite. The author reports two cases.

CASE 1.—A man, aged 31, had noticed a small tumor in the throat for several months. It was of the size of a lentil and was attached to the right anterior palatine arch, with a broad base, extending to the surface of the tongue. It had the appearance of a fibro-epithelioma. Under cocaine anesthesia, the tumor was removed. In two weeks, the wound had healed without a scar.

CASE 2 (former case of Roedelius and Brack).—A woman, aged 70, had for a long time noticed a swelling on the left margin of the tongue rather far back, which was painful and had increased rapidly in size. A surgeon thought that the swelling was a circumscribed phlegmon of the tongue or an abscess, and incised it. A part of it was excised and sent to the author for examination. Culture revealed mainly diplococci in chain formation, besides some bacilli. The wound healed promptly. Just as in the first case, the histologic examination revealed *leptothrix*.

The process consists, first, of an irritation of the epithelium, leading to fibro-epithelioma; then a deep necrotizing process sets in. The epithelium remains intact, however, for a surprisingly long period. Contrary to the tendency of the streptotrichal organisms, especially actinomyces, *leptothrix* does not seem to enter the blood current from the lung (Glaser and Hart) and is not hereby carried to the brain (Lang) or to the other organs.

AMBERG, Detroit.

Society Transactions

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Regular Monthly Meeting, April 2, 1928

JOSEPH C. BECK, M.D., *Presiding*

OTITIS MEDIA; CARCINOMA OF ANTRUM; TUMOR OF PHARYNX. DR. JOSEPH C. BECK.

The first patient was a woman, aged 23, who was first seen sixteen years before presentation. At that time she had an acute exacerbation of chronic otitis media, with subacute mastoiditis and cholesteatoma. The condition required immediate operation, and with the assistance of Dr. William Ballinger a Heath operation was performed on one side and a radical mastoid operation on the other.

The patient was presented to demonstrate the effects of the treatment. She could hear the whispered voice at a distance of 20 feet and the high tones with the audiogram were preserved. This was one of the few cases in which the Heath operation gave permanently successful results. The case was interesting also because ether anesthesia was used, and the patient developed an infective bronchitis which persisted at the time of presentation. She remained in fairly good condition, but once a day expectorated a large amount of material which looked like pus.

The second case was one of carcinoma of the antrum, which was relieved by electrocoagulation. The growth was the size of an apple, under the zygoma and under the eye. Histologic examination proved the growth to be carcinoma. The entire lower floor of the orbit was removed, leaving the eye; at the time of presentation the vision was good. The lateral wall of the antrum into the zygomatic area was removed, and the entire front of the face, including the skin, was left wide open. The operation was performed in November, 1927, and tissue had been removed at monthly intervals since that time for examination. There had been no sign of recurrence to date. A violent erysipelas developed about six weeks before presentation, and her attending physician gave her a serum which influenced the local condition somewhat, and the general condition was markedly improved.

The third patient had a mixed tumor of the pharynx which appeared to rise from the styloid process. It appeared a few weeks after a tonsillectomy had been performed, one and a half years before presentation, and filled the right half of the palate and the anterior wall of the pillar, involving more than half the pharynx. Histologic examination proved it to be a myxofibrosarcoma. This tumor was shelled out completely from the capsule and removed in pieces, following which the cavity was filled with gauze and the incision in the median raphe of the pillar was closed. Within two weeks the growth began to recur, and at this time, two months after the operation, it was as large and as hard as before any operative intervention.

On looking up the literature, a report was found of eight cases of tumors of the palate similar to this one. Dr. Beck believed that if he had removed the capsule of the tumor, there would not have been a recurrence. It would have been difficult to dissect it out, but in the future he intends to make an attempt to destroy the capsule in such cases with an electric button, making the incision externally instead of in the median line. The patient's voice was good, which was important as he was an attorney. The growth was not malignant, except so far as it pressed on nerves and other vital structures.

MIXED TUMOR OF THE SOFT PALATE. DR. ROBERT SONNENSCHEIN.

A man, aged 30, was seen four months before presentation, with a large, firm, round, smooth swelling in the soft palate on the right side. The history stated that he had first noticed the increase in size, which was unaccompanied by pain, that he then had difficulty in swallowing and a marked change in voice. Under local anesthesia an incision was made through the mucosa, and the tumor, intact in its capsule, was shelled out. It was smooth, except for one or two rounded protuberances such as are seen in uterine fibroids. The wound was lightly packed and sutured, and the patient made an uneventful recovery. When seen three months later, there was no sign of recurrence. Histologic examination showed the growth to be a mixed tumor.

DISCUSSION ON PAPERS OF DR. BECK AND DR. SONNENSCHEIN

DR. GEORGE W. BOOT: I recently operated on a woman who had carcinoma of the antrum, which was accompanied by intense pain. An incision was made from the outer part of the orbit through the nose and upper lip, the entire flap turned back, the common carotid ligated and everything destroyed. Everything was removed from the midline of the hard and soft palates, including the floor of the orbit. The patient still has a voice that can be understood.

In regard to tumors of the pharynx, about four months ago I operated on a patient with such a tumor which was as large as a thumb and extended from the level of the larynx to the base of the skull. I had great difficulty in shelling it out because it extended so high up, and I used my finger for this purpose for fear of tearing the internal carotid, or some other large vessel. The tumor resembled a dermoid cyst and had a definite capsule. The result obtained was satisfactory, and the throat did not look any worse than following many tonsillectomies.

DR. JOSEPH C. BECK: Was there any cerebral or motor disease following the ligation of the common carotid? Also, was the skin left in the case of the carcinoma?

I think that even with a hole in the palate it is not easy to say whether or not there was any recurrence. In the case presented, the patient had a large hole in the face, but as soon as I am convinced that there is no recurrence a prosthesis will be prepared for her, although I shall not do any plastic work.

DR. G. W. BOOT: I ligated the common carotid because I expected severe hemorrhage from the internal carotid, and because the tumor extended so far back on the wall. This step was taken to obviate hemorrhage, and there was no trouble following the ligation.

In the other case, the skin was not involved, and I saw no reason why it should not be left to cover the area.

SOME OBSERVATIONS IN BRONCHOSCOPY. DR. EDWIN MCGINNIS.

Twenty years of experience with cases of foreign bodies have brought me nearly all types of cases for observation, and also about all the complications which can ensue. The ball-bearing cases have been instructive, as well as difficult of cure. A ball-bearing is easy to demonstrate with the x-rays and also easy to see at the end of the bronchoscope, but it is difficult to get a firm and efficient grasp on it on account of its smooth spherical surface. This problem was easily solved after I had a simple grasping forceps of peculiar power made for use in such cases.

Another case of interest was that of a boy, aged 8 years, who had inspired a piece of chicken bone. Crowing respirations and husky voice were the prominent symptoms. Direct examination revealed a piece of chicken scapula wedged into the trachea about 2 inches (5 cm.) below the larynx. The left vocal cord was cut at about the middle by the passage of the bone. It took quite a little teasing and manipulation to get the bone through the larynx, but this was finally accomplished without further damage to the vocal cords. For one week after the

operation, the voice was extremely husky. Then he went through a period of lost voice, and finally one month later could make only audible, squeaky sounds with great effort. Examination one month later revealed posterior portions of both cords flabby and a web formation present in the anterior commissure.

Two months after the operation, the boy returned to the hospital for further observation. Under general anesthesia and suspension, the web was removed and the edges of the cords smoothed off. Since then there has been steady improvement in the voice.

Twenty years ago, Dr. E. Fletcher Ingals was using general anesthesia in his endoscopic cases. Great difficulty was encountered because of the bronchial secretions which obscured the vision. Cotton and gauze swabs were employed by him to keep the bronchi and tube clear. Atropine was used to help dry up the secretion. I well remember the last case in which he used general anesthesia, because the patient died on the table. After this he employed local anesthesia, as did Chevalier Jackson.

With the perfection of the mechanical suction pump of Beck-Mueller, the difficulty of removing the secretion is eliminated, so that now in certain cases the complete relaxation and elimination of anxiety can be safely accomplished by a general anesthetic.

I have derived a great deal of satisfaction from eight cases of extraction of foreign bodies under ether anesthesia. Such ease of accomplishment, with little if any after-shock to the patient, has been gratifying.

Lastly, I made a bronchoscopic examination and performed aspiration and topical application on an asthmatic patient under ethylene anesthesia. This was safely and easily accomplished, and the patient awakened promptly at the completion of the procedure.

DISCUSSION

DR. GEORGE W. BOOT: I have never experienced any particular trouble as the result of an anesthetic, and I have used ether except in very small children. It has sometimes been difficult to decide whether or not to give an anesthetic. In one case the child had inhaled the rubber end of a lead pencil, and it was necessary to give a light ether anesthetic in order to get hold of this object and extract it.

I think that a corkscrew on the end of a piece of piano wire makes a good instrument for removing ball-bearings. I have used this a number of times in removing round objects, and it has worked well.

Every one who performs bronchoscopies encounters fistulas. I have had three or four deaths among patients who have swallowed open safety-pins, and believe that an open safety-pin in the esophagus is as dangerous a foreign body as the patient can swallow. Another patient died as the result of inhaling a peanut. In several cases, the patients had marked tracheitis. One child, aged 4, who had diabetes, had been on a diet of insulin for some time when he developed a marked obstruction and it was necessary to do a tracheotomy. For several days afterward I had to perform bronchoscopies several times daily to remove crusts that formed in the trachea.

An infant, seen recently, died because my advice was not followed. At times this child could breathe normally and then apparently he could not get any air. I advised a tracheotomy, but the attending pediatrician said he had seen many patients with similar cases recover without this operation, and it was not done. The following night, the child died. It appeared to have paralysis of the adductors and a flabby epiglottis. Postmortem examination did not show any signs of cerebral birth hemorrhage.

I think that many of the notches in the vocal cords smooth out in the course of time.

DR. ARTHUR M. CORWIN: In reference to paralysis of the adductors in cords fixed in the median line, with stridor, I recall a case seen some years ago in a young man who had had a thyroidectomy, with a resulting bilateral adductor paralysis. It was necessary to do something; so by means of the indirect method and punch forceps with a lateral bite, a piece was removed from each cord, leaving

a round hole in the middle of the glottis, which relieved the difficulty. The voice was temporarily lost, but after the wound healed in a healthy way there was normal breathing and the voice returned to a remarkable degree, even though the walls of both cords were punched out to the lateral margin. I believe that in all cases of bilateral adductor paralysis the punching out of a good sized piece of the middle of the cord is advisable. This is, of course, not a new procedure, but one too often overlooked.

DR. ROBERT SONNENSCHEIN: In reference to the toxicity of cocaine, Dr. Ross pointed out in his thesis that when cocaine and epinephrine are used together, the rise in the intracranial venous pressure is much greater than the combined pressure would be if these drugs were used separately. Therefore the danger from using the combination is greater than if one used the epinephrine and waited from four to five minutes until the rise in blood pressure had subsided before applying the cocaine.

DR. JOSEPH C. BECK: I have seen a good deal of bilateral paralysis of the adductors in my experience, usually following complete thyroidectomies. It is not so frequent now, but it still occurs as the result of thyroiditis. The bulbar paralysis is the most frequent, and as the result of the toxic condition the ascending paralysis occurs. Tumors in the esophagus are responsible in some cases. I saw a woman, aged 65, who was under observation because of cancer of the esophagus, which condition was diagnosed at the Mayo Clinic. The growth was of the squamous cell type, and the patient was given large doses of roentgen radiation, with the result that she could eat practically nothing. Within two weeks, however, she could swallow quantities of milk, water and soft food without difficulty, and was greatly improved for about a month when obstruction recurred. It was impossible to get a filiform through the mass, and a gastrostomy was performed, from which she recovered. However, she developed abductor paralysis which became complete within a week, and tracheotomy had to be done.

In reference to Dr. Corwin's remarks, I believe that the operation he described has been discarded because the results were not good. In their work they do a Killian laryngostomy, splitting the larynx and holding it open until it will remain so, when a plastic operation is done. I think that Frazier added much to this field by his work in neurosurgery. In the abductor paralysis occurring in children, I think one should keep the question of thyroiditis in mind.

DR. BOOT: I call attention to an article which appeared in the *Annals of Oto-Laryngology* a year or so ago, in which several cases of this sort were reported; in all of them it was found that the children had suffered from cerebral birth palsy.

DR. MCGINNIS: I tried removing both cords in abductor paralysis before Frazier described his operation; I found that the arytenoids pulled out lateral bands, and the same condition, namely, respiratory obstruction, gradually returned. I think that it would be a good idea to try to get one superior laryngeal nerve, and if this works to cut the other.

In reference to Dr. Good's remarks, I believe that his patient had such pronounced ankylosis of the neck that it was impossible to expose the larynx. I think that many cases of this type could be found in which it would be impossible to get extension even under a general anesthetic.

REMARKS ON THE AUDITOR AND THEORIES OF HEARING. DR. J. GORDON WILSON.

Dr. Wilson said that his experience with the auditor had been disappointing. Some patients claimed they could hear better, but on testing with tuning forks, improvement could not be demonstrated. One exception was the case of a young man who had improved so much that he was going to get an auditor and continue with its use.

As to resonance, it is claimed that there are two places in which this can take place, one in the tectorial membrane and the other in the basilar membrane.

The tectorial membrane consists of a jelly-like substance, and no one has ever demonstrated resonance in such a substance. In the basilar membrane, the fibers are arranged in different ways, with the fibers a little longer in some places than in others; from the physical standpoint, however, these fibers are not sufficient to account for the difference in selectivity. It has been shown, however, that in the cochlea there is a sufficient amount of tension to pull these fibers over.

If there are two physical mechanisms, how can one account for the fact that they are always in tune? This brings up the question of diplacusis, which is another difficulty.

The last difficulty is the "all or nothing" theory applied to hearing. If a nerve fiber is stimulated, it is stimulated for its whole force or not at all. No nerve fiber can give sufficient amplitude to give different amplitudes of hearing. If a nerve fiber is stimulated, it gives one response only. I no longer believe that only one fiber is stimulated, but a number, and the fiber that gives the result is the fiber at the apex, which might account for the difference in pitch. In the "all or nothing" theory only one amplitude would appear to be possible. Knudson said that there are usually associated nerve fibers, and in order to account for the amplitude he obtained he had to get ten fibers, but this is difficult to understand.

Dr. Dandy recently removed a whole half hemisphere, and on one occasion the entire temporal lobe, from a patient, and he heard as well afterward as before the operation. This appears to disprove the theory that the hearing is located bilaterally in the temporal lobe.

I know of no theory that would completely satisfy any theory of hearing.

DISCUSSION

DR. SAMUEL SALINGER: I am reluctant to discuss the auditor because sufficient experiments have not been conducted to permit of definite conclusions. A machine was installed in the Cook County Hospital in the summer of 1927, and they attempted to run a series of cases. It required a great deal of time to do this satisfactorily, but enough of the patients persisted so that they had a series of thirty odd patients who received treatment regularly over two or three months. The results were disappointing. I cannot recall a single case in which the tests demonstrated any improvement, and in some instances I found a distinct loss for certain words or numbers. The instrument had no influence on hearing as determined by tuning forks or the Galton whistle.

I had deferred making any formal report until I could persuade more patients to continue the treatment, but I hoped within a few months to be able to offer something definite. I cannot understand how the machine could influence the hearing, although it is supposed that the to-and-fro motion of the cap-shaped piece of metal produces vibrations in the atmosphere which increase the hearing, working on the principle that the vibrations in the surrounding atmosphere overcome the conducting apparatus.

I do not think that any new method of treatment should be condemned until it has had a fair trial, but I do think that any one who is going to use this instrument should do so under proper regulations, so far as testing the hearing is concerned. It is impossible to base any deductions on the statements of the patients because of the psychologic effect of any new treatment.

DR. ROBERT SONNENSCHEIN: My attention was called to an article in the *Literary Digest* about two years ago, in which this instrument was described for the first time. I have seen the instrument only once and have had no experience with its use. The theory that the production of tones of great amplitude would mask the low tones produced by the voice, and thereby allow the deaf to hear better, seems to me to be rather strange. In his textbook, Troelsch stated that the reason patients with paracusis hear better in the presence of noise is because the persons talking to them speak louder at such times. The reason ascribed to the fact that apparently such persons hear better on trains is because the vibrations work on the foot-plate; however, experiments have shown that it is

probably because the low tones to which they are deaf do not disturb them, but they do disturb the person with good hearing who is talking to the deafened one. The person who hears and who is disturbed by the noise speaks much louder, so that the deaf person hears much better. When an intense tone of low pitch is produced, the person hears the high tones better for the time being on the theory that if the drum membrane is in an unfavorable position the low tones of great amplitude carry the drum membrane to a better position, and the high tones are heard better.

I am glad that Dr. Salinger has taken the trouble to investigate the machine, for unless a new apparatus is tested properly the manufacturers so favorably influence the medical profession that many persons put such an apparatus in their office and use it on all patients, regardless of the pathologic condition present.

Dr. Otto Stein: My attention was directed to the auditor two years ago, and I was sufficiently interested in it to offer to make a few experiments to determine whether or not it had any value. I stipulated that the apparatus be placed in my clinic at the Post-Graduate Hospital, and that I would test the patients before they were treated as the manufacturer wished them to be treated and again afterward. This was done and actual records were secured of sixty patients treated in this manner. After comparing notes, it was found that not more than half a dozen of the patients showed any improvement in the whispered voice test. Immediately after this treatment the patients were treated by the usual methods — inflation, massage and so on — and in most instances they were able to show a substantial increase in hearing after the usual methods were employed. After six months, I requested that the apparatus be removed.

Dr. George W. Boot: In reference to the resonating structure in the ear that Shambaugh definitely proved was not the basilar membrane, I think that no one has proved that because the tectorial membrane is jelly-like it cannot vibrate. Any one who had eaten jelly knows it can vibrate. It is well known that many abscesses cause loss of hearing. Bassoe reported a case in which only one hemisphere was present, and yet the patient had the use of both sides of the body. I had one patient who said he could hear a pin drop in a boiler shop. Another patient placed a noisy suction apparatus on a table by the patient, and the patient could hear plainly when this was in operation, but he could not hear when this was turned off. This was also true of tuning fork tests. There certainly could be no increase in intensity of the vibrating fork when the noise stopped.

Dr. Joseph C. Beck: Two years ago I requested Dr. Ira Frank to accompany me to the place where the auditor was made, but I did not become sufficiently enthusiastic to have one placed in our clinic. There was one very noisy machine that was of no value. I think that the medical profession should try anything that would be of assistance to deafened persons, but that investigations must be carefully controlled. Recently, a scientist from Prague published an article on the use of arsenic in the treatment of deafness, which seemed so promising that it was tried on several patients, but improvement was not noted in a single instance.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OTOLOGY AND LARYNGOLOGY

Regular Meeting, Nov. 21, 1928

James A. Babbitt, M.D., *Chairman*

Intratracheal Ether. Dr. P. J. Flagg.

In order to secure the best results in surgical procedures, cooperation must exist between the anesthetist and the surgeon. In operations on the head and neck and upper air passages, it is difficult for the anesthetist, using the ordinary methods of anesthesia, to avoid hindering the work of the surgeon. On account

of this fact, in operations on the upper air passages, the head and the neck the use of ether administered intratracheally is advocated. Certain instruments have been devised by him which have as their primary aim simplicity of construction and ease of manipulation. A detailed description of these instruments may be found in the ARCHIVES OF OTOLARYNGOLOGY, May, 1927, and May, 1928. Another article, in *The Journal of the American Medical Association* for September 15, describes this method. The apparatus used consists of a laryngeal portion about 4 inches (10.16 cm.) in length, which is identical in construction with the Jackson bronchoscope. To this is attached a flexible portion long enough to permit its coming well out of the mouth. This apparatus is introduced under direct vision by means of a pocket-size electric laryngoscope devised by Dr. Flagg, a rigid obturator having previously been placed inside the flexible portion of the apparatus. After insertion, the obturator is withdrawn, and the tubing is connected with an ether can, in the top of which several holes have been placed. The can contains about 1 ounce of ether, and by shaking, sufficient vapor is given off through the tube to maintain surgical anesthesia.

No irritation of the larynx has been observed by using this method. In addition, the presence of the bronchoscope in the larynx prevents the inhalation of blood during the operation. An apparatus designed by Dr. Flagg for the resuscitation of patients suffering from asphyxiation was demonstrated.

DISCUSSION

DR. FIELDING O. LEWIS: By this apparently simple method described by Dr. Flagg, the objections to intratracheal anesthesia are largely overcome. In using other methods, so much complicated apparatus is essential that in most clinics the use of this type of anesthesia had been abandoned.

DR. GEORGE FETTEROLF: How far should the tube be inserted into the trachea? I should also like to know if this apparatus has been used in any thymic cases.

DR. FLAGG: The tube is inserted its full length which brings the tip about 1 inch (2.54 cm.) from the bifurcation of the trachea. So far, I have not had an opportunity to use this device in thymic cases.

NITROUS OXIDE ANESTHESIA AND TONSILLECTOMY. DR. JOHN H. EVANS (by invitation).

The paper of Dr. Evans was based on his expericence in 6,000 cases of tonsillectomy in which operation was performed by using nitrous oxide and oxygen alone, and 10,000 cases of tonsillectomy in which nitrous oxide, oxygen and ether were used. As in all surgical maneuvers, the safety of the patient demands first consideration, necessitating careful preoperative study and examination. The surgeon who demands a continuously relaxed throat for tonsillectomy should not use nitrous oxide, but if he is willing to tolerate slight interruptions to regain the desired stage of anesthesia, nitrous oxide can easily be used. Of primary importance, however, is a well trained anesthetist, preferably one having a medical training, as careful attention to small details is essential. Dr. Evans uses an apparatus carrying a large volume of gas, which can be operated by either foot or hand throttles. This gas is administered through a specially constructed nasal attachment and through several oral tubes as well. The advantages of this method are: 1. It is pleasant for the patient. 2. It can be used without danger when pathologic conditions of the chest are present. 3. It is not explosive. 4. The cough reflex is not abolished. 5. It does not subject the surgeon to prolonged ether inhalation. The two main disadvantages of this method are: 1. The surgeon is sometimes inconvenienced for a short period of time in order to reduce the patient to the proper stage of anesthesia. 2. The surgeon may be spattered with blood on account of the vigorous "blowing" of the patient.

In addition to the disadvantages, nitrous oxide has certain peculiarities not possessed by chloroform or ether. Sometimes it is difficult to estimate the depth

of anesthesia. Color is not always a reliable guide, and muscle signs must be carefully watched. There is usually an initial rise of blood pressure followed by a fall. Twitching of the facial muscles is frequently observed in young children. The cost of administering nitrous oxide in tonsillectomy averages about ten dollars per case. This prevents its being used as routine in ward cases.

DISCUSSION

DR. C. M. BROWN: On account of the expense of this type of anesthesia, I limit its use to those who can easily afford the additional cost of anesthesia, and to cases in which other types of anesthetic are contraindicated. It is important to gain the confidence of the patient. The whole procedure is time-saving; the prompt induction of anesthesia and regaining of consciousness after operation is advantageous, and the operation can be just as thoroughly performed as when ether is used.

COLONIC ANESTHESIA. DR. EDWARD W. BEACH.

This type of anesthesia is essentially suitable for prolonged operations on the head, neck, and the upper air passages. The contraindications to its use are: (1) poor surgical risks; (2) cases in which deep relaxation is necessary; (3) cases in which there are pathologic processes of the rectum; (4) emergency operations, and (5) cases in which the anesthetic must be under absolute control. The advantages of the use of this anesthetic are: (1) the anesthetist is away from the field of operation; (2) apprehension is lessened; (3) there is less pulmonary irritation, and (4) nausea and vomiting are less marked. Certain rules which must be followed for the successful use of this type of anesthesia are: (1) watchfulness at all times; (2) the variation of dosage according to the case; (3) the administration of a laxative two nights before the operation; (4) high colonic irrigations twenty-four, twelve and two hours before operation, and (5) good sleep and light diet the day before.

The administration of the anesthetic is carried out in the patient's room. One hour before administration, morphine and atropine are given hypodermically. Sometimes paraldehydes are added to the ether oil mixture.

The danger signs are: (1) collapse of the patient during administration; (2) a rapid fall of reflexes; (3) cyanosis, and (4) embarrassed respiration. In cases in which absorption is slow, some ether by mouth may be necessary. The aftercare involves the removal of the unabsorbed solution, and flushing of the bowel by colonic irrigation.

DISCUSSION

DR. FRANCIS CLARK GRANT: I have used this method in ninety neurosurgical cases with gratifying results. Usually 2 ounces of ether mixed with the proper amount of oil given an hour before operation gives adequate analgesia for cases in which surgical measures on the spinal cord and the head are indicated. This is usually reinforced by the same mixture being given during the operation by Murphy drip. In cases in which the head and spinal column are involved, local infiltration of procaine hydrochloride is used in addition to the colonic ether.

Directory of Otolaryngologic and Ophthalmologic Societies *

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY

Chairman: Dr. William V. Mullin, Cleveland Clinic, Cleveland.
Secretary: Dr. Gabriel Tucker, Bronchoscopic Clinic, University Hospital, Philadelphia.
Place: Portland, Ore. Time: July 8-12, 1929.

AMERICAN BRONCHOSCOPIC SOCIETY

President: Dr. C. J. Imperatori, 17 E. 38th St., New York.
Secretary-Treasurer: Dr. Louis H. Clerf, 128 S. 10th St., Philadelphia.

AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. Bryson Delavan, 40 E. 41st St., New York.
Secretary: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Place: San Francisco. Time: July 4-6, 1929.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Hill Hastings, 1136 W. 6th St., Los Angeles.
Secretary: Dr. R. L. Loughran, 33 E. 63d St., New York.
Place: San Francisco. Time: July 4-6, 1929.

AMERICAN OTOLOGICAL SOCIETY

President: Dr. J. Gordon Wilson, 104 S. Michigan Ave., Chicago.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Harris P. Mosher, 828 Beacon St., Boston.
President-Elect: Dr. William H. Wilder, 122 S. Michigan Ave., Chicago.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: Atlantic City, N. J.

LOCAL

THE COLORADO OTO-LARYNGOLOGICAL SOCIETY

President: Major Royal Reynolds, Fitzsimons General Hospital, Aurora.
Secretary: Dr. Rex L. Murphy, Metropolitan Bldg., Denver.
Place: Assembly Room of Metropolitan Bldg. Time: First Saturday of each month from October to May.

SECTION ON OPHTHALMOLOGY AND OTO-LARYNGOLOGY OF THE MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA

Chairman: Dr. Walter A. Wells, 1606, 20th St. N. W., Washington.
Secretary: Dr. J. N. Greear, Jr., 1740 M St., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

ATLANTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Arthur J. Fort, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Leon E. Brawner, 157 Forrest Ave. N. E., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. N. E. Time: 8 p. m., last Thursday of each month.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Arthur M. Corwin, 25 E. Washington St., Chicago.
Secretary: Dr. Austin A. Hayden, 25 E. Washington St., Chicago.
Place: Grill Room, Stevens Restaurant, 16 N. Wabash Ave. Time: 6 p. m., first Monday of each month from October to May.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Lafayette Page, Hume-Mansur Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. J. Raymond Hume, Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. A. Wagner, Pere Marquette Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital, New Orleans. Time: 8 p. m., third Thursday of each month from September to June.

SECTION ON OTOLOGY AND LARYNGOLOGY OF THE BALTIMORE CITY MEDICAL SOCIETY

Chairman: Dr. Waitman F. Zinn, Medical Arts Bldg., Baltimore.
Secretary: Dr. Moses L. Breitstein, 1212 Eutaw Pl., Baltimore.
Place: 1211 Cathedral St. Time: 8:30 p. m., last Friday of each month.

DETROIT OTO-LARYNGOLOGICAL SOCIETY

President: Dr. William Fowler, 1048 Maccabees Bldg., Detroit.
Secretary-Treasurer: Dr. Don A. Cohoe, 13535 Woodward Ave., Detroit.
Place: Maccabees Bldg. Time: Third Wednesday evening of each month from October to May.

THE KANSAS CITY EYE, EAR, NOSE AND THROAT SOCIETY

President: T. S. Blakesley, Lathrop Bldg., Kansas City, Mo.
Secretary: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

NEW ENGLAND OTOLOGICAL AND LARYNGOLOGICAL SOCIETY

President: Dr. Francis P. Emerson, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Charles T. Porter, 520 Commonwealth Ave., Boston.

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Lee W. Hughes, 1019 Broad St., Newark.
Secretary: Dr. Earle LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

THE SECTION OF LARYNGOLOGY AND RHINOLOGY OF THE NEW YORK ACADEMY OF MEDICINE

Chairman: Dr. David H. Jones, 114 E. 54th St., New York.
Secretary: Dr. Edward Frankel, Jr., 152 W. 58th St., New York.
Place: 103d St. and 5th Ave. Time: 8:30 p. m., fourth Wednesday of each month from October to May.

THE OTOLOGICAL SECTION OF THE NEW YORK ACADEMY OF MEDICINE

Chairman: Dr. Clarence H. Smith, 2 E. 54th St., New York.
Secretary: Dr. James Garfield Dwyer, 57 W. 57th St., New York.
Place: 103d St. and 5th Ave. Time: Second Friday of each month from October to May.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. M. S. Lord, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.

CINCINNATI OTO-LARYNGOLOGICAL SOCIETY

President: Dr. C. C. Jones, Doctors Bldg., Cincinnati.
President-Elect: Dr. Harris H. Vail, 24 E. 8th St., Cincinnati.
Secretary-Treasurer: Dr. M. F. McCarthy, 2600 Union Central Bldg., Cincinnati.
Place: University Club. Time: 6:45 p. m., second Tuesday of each month from October to May.

THE OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SECTION OF THE CLEVELAND ACADEMY OF MEDICINE

Chairman: Dr. A. B. Brunner, Guardian Bldg., Cleveland.
Secretary: Dr. A. L. Stotter, 1148 Euclid Ave., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Robert R. Hampton, Boston Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.
Place: Salt Lake City. Time: July 1-3, 1929.

PHILADELPHIA LARYNGOLOGICAL SOCIETY

President: Dr. Ralph Butler, 2007 Chestnut St., Philadelphia.
Secretary: Dr. Herman B. Cohen, 13th and Spruce Sts., Philadelphia.
Place: College of Physicians. Time: 8:30 p. m., first Tuesday of each month from October to June.

THE SECTION ON OTOLOGY AND LARYNGOLOGY OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA

Chairman: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Clerk: Dr. Frederick M. Strouse, 13th and Spruce Sts., Philadelphia.
Place: College of Physicians. Time: 8:30 p. m., third Wednesday of each month from October to June.

THE MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. John G. McLaurin, Medical Arts Bldg., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, Medical Arts Bldg., Dallas, Texas.
Recording Secretary: Dr. L. M. Sellers, Medical Arts Bldg., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. F. H. Roseborough, 302 Moore Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library, San Antonio. Time: 8 p. m., first Tuesday of each month from October to May.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. H. L. Warwick, Medical Arts Bldg., Fort Worth, Texas.
Secretary: Dr. A. E. Jackson, Medical Arts Bldg., Fort Worth, Texas.
Place: University Club. Time: 6 p. m., first Friday of each month except August.

EYE, EAR, NOSE AND THROAT SECTION OF THE HOUSTON ACADEMY OF MEDICINE

President: Dr. S. T. Pullium, Medical Arts Bldg., Houston, Texas.
Secretary: Dr. R. M. Hargrave, Esperson Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

THE MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. L. P. Allen, 145½ Main St., Oshkosh, Wis.
Secretary-Treasurer: Dr. Edward R. Ryan, 425 E. Water St., Milwaukee.
Pleace: University Club. Time: 6:30 p. m., third Tuesday of each month.

News and Comment

TESTIMONIAL DINNER TO DR. JAMES F. McKERNON

A testimonial dinner was tendered to Dr. James F. McKernon by the Faculty Association of the New York Post-Graduate Medical School and Hospital on Jan. 9, 1929. Dr. McKernon has retired as president of the hospital, after giving many years of service to the institution, but is retaining membership on the board of directors. Among the speakers at the dinner were: Dr. J. M. T. Finney of Johns Hopkins University Medical School; Dr. Livingston Farrand, president of Cornell University, and Dr. Edward H. Hume and Dr. Arthur F. Chace of the New York Post-Graduate Hospital.

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Manuscripts for publication, books for review, and correspondence relating to the editorial management should be sent to Dr. George E. Shambaugh, Editor-in-Chief, 122 South Michigan Avenue, Chicago, or to any other member of the Editorial board. Communications regarding subscriptions, reprints, etc., should be addressed, ARCHIVES OF OTOLARYNGOLOGY, American Medical Association, 535 North Dearborn Street, Chicago.

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